

Reference

# GRADUATE COLLEGE CATALOG

UNIVERSITY OF ILLINOIS AT CHICAGO CIRCLE 1968-1969

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# **THE GRADUATE COLLEGE**

**The University of Illinois  
at  
Chicago Circle**



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# ACADEMIC CALENDAR

## 1968-1969

### Fall Quarter

September 23, 24 (M, Tu)  
September 26, Th  
November 28, 29 (Th, F)  
December 6, F  
December 9-13 (M-F)

Registration and orientation  
Instruction begins  
Thanksgiving (vacation)  
Instruction ends  
Final examinations

### Winter Quarter

January 2, 3 (Th, F)  
January 6, M  
March 14, F  
March 17-21 (M-F)

Registration and orientation  
Instruction begins  
Instruction ends  
Final examinations

### Spring Quarter

March 27, 28 (Th, F)  
March 31, M  
May 16, F  
May 30, F  
June 6, F  
June 9-13 (M-F)  
June 15, Sun

Registration  
Instruction begins  
Honors Day  
Memorial Day (holiday)  
Instruction ends  
Final examinations  
Commencement

### Summer Quarter

June 19, 20 (Th, F)  
June 23, M  
July 4, F  
August 29, F  
September 1, M  
September 2-6 (Tu-Sat)

Registration  
Instruction begins  
Independence Day (holiday)  
Instruction ends  
Labor Day (holiday)  
Final examinations

## 1969-1970

### Fall Quarter

September 22-26 (M-F)  
September 29, M  
November 27, 28 (Th, F)  
December 5, F  
December 8-12 (M-F)

Registration and orientation  
Instruction begins  
Thanksgiving (vacation)  
Instruction ends  
Final examinations

### Winter Quarter

December 15-19 (M-F)  
January 5, M  
March 13, F  
March 16-20 (M-F)

Registration and orientation  
Instruction begins  
Instruction ends  
Final examinations

### Spring Quarter

March 23-27 (M-F)  
March 30, M  
May 15, F  
June 5, F  
June 8-12 (M-F)  
June 14, Sun

Registration  
Instruction begins  
Honors Day  
Instruction ends  
Final examinations  
Commencement

### Summer Quarter

June 15-19 (M-F)  
June 22, M  
August 28, F  
August 31-September 4 (M-F)

Registration  
Instruction begins  
Instruction ends  
Final examinations



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Director, University Honors Programs .....	NAN E. MCGEEHEE
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Associate Director, Personnel Services .....	JOSEPH S. CARLSON
Campus Director, Physical Plant .....	FRANK W. HOUCK
Director, Auxiliary Services .....	JAMES J. OVERLOCK
Director, Chicago Circle Center .....	DALE BROSTROM
Commandant, R.O.T.C. ....	MAJOR ROBERT P. JOHNSTON

## Departments Offering Graduate Work

### *Biological Sciences*

John O. Corliss, Head  
518 Science and Engineering Offices

### *Chemistry*

William F. Sager, Head  
715 Science and Engineering Offices

### *Energy Engineering*

James P. Hartnett, Head  
912 Science and Engineering Offices

### *English*

Robert B. Ogle, Head  
2131 University Hall

### *Geology*

Werner H. Baur, Head  
225 Science and Engineering Offices

### *German*

Robert R. Heitner, Head  
1605 University Hall

### *History*

Robert V. Remini, Chairman  
1928 University Hall

### *Materials Engineering*

Ernest F. Masur, Head  
816 Science and Engineering Offices

### *Mathematics*

Joseph Landin, Head  
322 Science and Engineering Offices

### *Philosophy*

George T. Dickie, Acting Head  
1803 University Hall

### *Physics*

Swaminatha Sundaram, Head  
1240 Science and Engineering Offices

### *Psychology*

Harry S. Upshaw, Acting Head  
217 Roosevelt Road Building

### *Social Work*

W. Paul Simon, Assistant Director  
1312 University Hall

### *Sociology*

Robert L. Hall, Head  
1810 University Hall

## **Graduate College**

2323 University Hall

The University of Illinois at Chicago Circle  
Box 4348

Chicago, Illinois 60680

## **Campus History and Information**

The University of Illinois at Chicago Circle was activated in 1965, not as a new institution but as the successor to the Chicago Undergraduate Division, through which the University of Illinois for 19 years provided the first two years of college and preprofessional work for over 100,000 commuting college students of the Chicago area.

In the spring of 1946 the University realized that men and women from the Armed Services could not be admitted to the main campus at Champaign-Urbana because it was impossible to construct additional facilities in time to meet the demand. Restricting enrollment was undesirable; therefore, Navy Pier, already used as a school and adaptable to the needs of a freshman-sophomore program, was leased by the Board of Trustees to organize the Chicago Undergraduate Division. That fall, 3800 students, three-fourths of them veterans, were enrolled. Although the percentage of veterans dropped slightly in 1947, enrollment rose above 4500.

In January, 1961, the Board of Trustees approved the granting of baccalaureate degrees by the Chicago Undergraduate Division as soon as an adequate campus was available: the site, where the Eisenhower, Ryan, and Kennedy Expressways converge, was selected in 1961, the Chicago Undergraduate Division became the University of Illinois at Chicago Circle, and the campus was occupied on February 22, 1965.

Thirteen graduate programs were offered in September 1967. Subsequently, an additional master's program and four doctoral programs have been approved. In the near future additional departments will offer work for the M.A., the M.S., and the Ph.D. Professional programs will also be initiated soon.

Other University of Illinois facilities in Chicago are at the Medical Center, which houses the Colleges of Medicine (including the School of Associated Medical Sciences), Dentistry, Nursing, and Pharmacy and the Health Sciences Division of the Graduate College.

## **Location and Transportation**

The Chicago Circle campus is located just south and west of the Loop in an area bounded by the Eisenhower and Ryan Expressways, Racine Avenue, and Roosevelt Road. The mail address is Box 4348, Chicago, Illinois 60680. Transportation to the campus is by way of the CTA, which has built a station at Peoria Street especially to serve Chicago Circle, and by the buses on Halsted, Harrison, and Taylor streets and on Roosevelt Road.



## Programs

The Graduate College of the University of Illinois at Chicago Circle offers programs leading to the master's degree in these disciplines:

Biological Sciences	Materials Engineering
Chemistry	Mathematics
Energy Engineering	Philosophy
English	Physics
Geology	Psychology
German	Social Work
History	Sociology

Programs leading to the doctorate are offered in the following departments:

Chemistry	Mathematics
History	Philosophy

## Admission

The academic year at Chicago Circle consists of three 11-week quarters (including the final examination periods), which begin in September (fall quarter), January (winter quarter), and March (spring quarter). The 11-week summer quarter begins in June. A student may seek admission to any one of the four quarters.

Inquiries about admission and related matters should be directed to the department in which the applicant wishes to enroll. To be considered for admission to the Graduate College, the applicant must meet these conditions:

1. He must be a graduate of an institution awarding a baccalaureate degree comparable to that granted by the University of Illinois.
2. He must be adequately prepared for advanced study as demonstrated by his previous program of study and his scholastic record.
3. He must be recommended for admission by the department to which he has applied and by the Dean of the Graduate College. Departmental recommendation is based on factors that include but go beyond a satisfactory scholastic average; hence, an acceptable scholastic average alone does not insure admission.
4. He must present a minimum admission average of 3.50 ( $A=5.00$ ), which is computed on the basis of the last 60 semester hours or 90 quarter hours. Some departments require a higher admission average; consult the section of this publication that pertains to the several departments. An applicant with an average of less than 3.50 should not apply. Several departments advise applicants to take the Graduate Record Examination or to provide further evidence of scholastic attainments.

Applicants for post-master's work and doctoral candidacy who have earned a master's degree or at least 32 semester hours (48 quarter hours) of graduate study are considered for admission on the basis of two scholastic grade-point

averages: one, for the last 60 semester hours (90 quarter hours) of undergraduate study; the other, for all graduate course work completed at the time of application. Credit for work completed elsewhere is described in *Academic and General Regulations*.

## **Admission of Foreign Students**

A foreign student must meet all of the requirements above and pass the English Proficiency Test, as explained below. He should also submit with his initial inquiry copies of his complete official academic records which have been certified by the educational institutions he has attended. Included must be a list of all degrees, diplomas, or certificates awarded and an authenticated translation of all documents submitted in a language other than English. In order to allow sufficient time for processing foreign student applications, requests should reach the departmental office four to six months before the beginning of the quarter to which the applicant seeks admission.

Because it is not advisable to undertake a graduate program at the University of Illinois at Chicago Circle without competence in the English language, an applicant whose native tongue is not English is required to take an English proficiency test. Arrangements for this test (TOEFL) may be made by writing to:

Test of English as a Foreign Language  
Educational Testing Service  
Princeton, New Jersey 08540.

The test is administered in October, January, April, and June.

## **Applications**

Applications for admission may be obtained from the department to which the student is applying, from the Office of Admissions and Records, 327 University Hall, or from the Graduate College, 2323 University Hall. Department offices are listed on page ?? . A prospective student should apply for admission at least two months before the beginning of the quarter in which he expects to enroll. The deadlines for receipt of completed applications for admission to a specific quarter, together with all required supporting documents, are:

Fall quarter, August 31.  
Winter quarter, December 15.  
Spring quarter, February 15.  
Summer quarter, May 15.

Applications will be acted on only when official copies of all transcripts and other credentials have been received by the department in which the applicant wishes to enroll.

Medical examinations are required of all students before their first registration. The examination is made by the family physician at the student's expense.

## **Readmission**

Students who find it necessary to be away from campus (not registered) for more than one quarter may be granted a leave of absence. Such action is initiated by a request from the student's department to the Graduate College specifying the length of time and reasons for the absence. After approval by the Graduate College the petition will be forwarded to the Office of Admissions and Records. Upon review by the department and Graduate College that office in turn will arrange for readmission without reapplication. Any student who has not been granted a leave of absence and who does not register after one quarter's absence must file an application for readmission with the Office of Admissions and Records.

## **Work Completed Elsewhere**

A student who has completed graduate courses in a recognized institution without receiving a degree may petition the Graduate College for credit toward an advanced degree after consultation with his adviser and his department. Recommendation for allowance (or disallowance) of transfer credit is a departmental matter. The department concerned shall submit to the Graduate College its recommendations including the courses requested for credit transfer, those allowed, those disallowed, and the applicable grades. No courses applied toward an undergraduate program leading to a bachelor's degree may be counted. The number of credits which may be transferred is determined on an individual basis. Six quarter hours are the equivalent of 4 semester hours (or, at the Urbana Campus, 1 semester unit of graduate credit). Most graduate courses carry 4 quarter hours of credit.



## **Academic and General Regulations**

A student should familiarize himself with the academic requirements and regulations of the Graduate College and of the department in which he is working. He is responsible for complying with these regulations and for fulfilling all requirements for his particular degree. Every graduate student should have a Graduate College Catalog and, if available, a departmental brochure, for they are official statements of policy. The normal procedures and requirements of the Graduate College are indicated in this Catalog.

### **Petitions**

A student may petition the Dean of the Graduate College for exceptions to any of the following regulations, but he should do so only after consultation with his adviser and the departmental coordinator of graduate studies. Forms for such petitions may be secured from the Graduate College.

### **Residence**

Each degree candidate must spend a period of time in residence as follows:

*For the Master's degree:* 24 hours in regularly scheduled courses taken within one calendar year. Exceptions to this requirement, e.g., for students with acceptable transfer credit or part-time students, may be granted by the Graduate College upon recommendation of the department.

*For the degree of Doctor of Philosophy:* 24 hours beyond the Master's level (or its equivalent) in regularly scheduled courses (excluding thesis research) must be earned at the University of Illinois at Chicago Circle. Three consecutive quarters of at least 8 hours per quarter (which may include thesis research) must be taken at this university. Exceptions may be granted by the Graduate College upon recommendation of the department.

### **Time Limitations for Advanced Degrees**

A candidate for a Master's degree must complete all requirements for the degree within four calendar years after his initial registration in the Graduate College. Doctoral candidates must complete their degree requirements within six years after receiving the Master's degree or its equivalent. In special circumstances the student, on consultation with his adviser, may petition the Graduate College and his department for an extension of this time limit.



## Advisers

Each graduate student must have an adviser in the department in which he is a degree candidate. The adviser assists in planning a program of graduate study which fits the needs of the student and satisfies departmental and Graduate College requirements. A new student should contact his major department to discuss the selection of an adviser. Many departments have a coordinator of graduate studies whose responsibilities include direction of all graduate work in that department.

## Courses of Instruction

Courses open to graduate students are of two types. Those numbered from 300 to 399 are open to advanced undergraduates and graduate students. Those numbered 400 to 499 are generally open only to graduate students. Some 300-level courses are available for graduate credit in departments other than those offering advanced degrees. Students should consult their adviser regarding the possibility of using these courses as minors.

A number of courses offer variable credit. At the 300 level, additional work in the nature of special reports, papers, or projects is required of a student who registers for the maximum credit shown. At the 400 level, some research, reading, and independent courses provide variable credit; proportionate time devoted to a particular activity can thus be indicated on the student's record.

## Grades

*Minimal Grade Requirements.* Any student may be dropped by the Graduate College upon the recommendation of the department. If the cumulative average of courses taken for credit falls below 3.5 at the end of any quarter, the student will be placed on probation. If the cumulative average remains below 3.5 at the end of the regular academic year or any three quarters, the student will be dropped from the Graduate College. Departments may set higher standards.

*EX and DF.* At the end of a continuing course sequence the deferred grade for all quarters must be converted either to a specific letter grade or to the Ex grade. Deferred grades should be used only for thesis research (499) or other research, continuing seminar or sequential courses, and independent study.

*Pass-Fail Grades.* A graduate student may take courses on a pass-fail basis provided that:

1. the courses are not within the student's immediate area of specialization;
2. such courses account for no more than 1/6 of the total number of course hours taken at the University of Illinois at Chicago Circle and counted toward the degree;
3. the student declare his intention to take a course on this basis at the time of registration.

*Drop Rule.* Until the end of the sixth week of the quarter a student may drop a course without penalty. Thereafter the course may not be dropped.

# Maximum and Minimum Registration

The academic work carried by assistants and others on the University staff is limited by statute, and those employed outside the University are expected to plan their programs of study in accordance with these regulations. Students holding University Fellowships or other fellowships awarded by the University must carry a full program of 16 quarter hours or the equivalent. Those awarded tuition and fee waivers must carry a minimum program of 12 quarter hours or the equivalent. The academic work carried by a graduate student who holds an assistantship is limited by statute as follows:

<u>Appointment</u>	<u>Maximum hours per quarter</u>
Full	4
3/4	8
2/3	9
1/2	12
1/3	15
1/4	16

## Auditing Privileges

A graduate student regularly registered may be permitted to attend classes as an auditor without credit at the discretion of the instructor in charge of the course. Students wishing to have their audited courses recorded must pay a fee (see Tuition and Fees, p. 00). Persons not registered in the University of Illinois are permitted to attend classes, other than laboratory courses, as auditors provided they pay the fee and file with the Office of Admissions and Records a permission form bearing the approval of the instructor and the Dean of the Graduate College. A student should not enter on his program card any courses which he plans to attend as an auditor.

## Regulations Pertaining to Degrees

### The Master's Degree

The following are the requirements of the Graduate College only: departmental requirements are in addition to these. A minimum of 48 quarter hours is required for the master's degree. At least 16 of the 48 quarter hours must be in courses numbered 400 and above, and 12 of these 16 must be in the major field. At least 24 quarter hours must be taken in the major field of interest; the remaining credit may be in that field or in other courses appropriate to the student's educational goals. No more than 18 quarter hours of credit in 499 (the thesis research course) may be included in a 48-hour program. The normal load is 16 quarter hours; however, a student is classified as full time if he is

registered for 12 quarter hours or more. Under special conditions with the approval of his adviser a student is permitted to register for up to 20 quarter hours. Twenty-four quarter hours (which may include thesis research) must be earned at the University of Illinois at Chicago Circle. Exceptions may be granted by the Graduate College upon recommendation of the department.

*Examination for the Master's Degree.* Examination requirements, if any, are determined by the department. The Graduate College shall have the recommendation of a departmental committee consisting of at least three persons, one of whom must have at least master's standing or the equivalent.

*Thesis.* A student electing or required to write a master's thesis should file the title of the thesis with the Graduate College at least six weeks prior to graduation. No more than 18 quarter hours of thesis credit may be included in a 48 quarter hour program. Credit in thesis research cannot be applied to a degree until the thesis is accepted. For specific instructions regarding the format of the thesis the student should obtain a copy of the leaflet "Instructions for Preparation of Theses" from the Graduate College Office, 2323 University Hall.

## **The Doctoral Degree**

The degree of Doctor of Philosophy is offered in chemistry, philosophy, mathematics, and history. The general requirements for this degree are described below, and any special requirements are given in the departmental listings.

Each student's schedule of course work and research is planned in consultation with his adviser with consideration given to the candidate's previous academic training, his career objective, the general regulations of the Graduate College, and any specific departmental requirements. It is the student's responsibility to be aware of these regulations and requirements and to satisfy them as early as possible. The major area of specialization consists of a selection of courses closely related to each other, not all of which are necessarily offered by the major department. If a student elects or is required by departmental regulations to declare a minor outside his major department, the selection of courses must be approved by the departments or divisions concerned. A minor area of specialization consists of a group of course offerings that have a distinct relationship, though they may be offered in more than one department.

*Foreign Language Requirement.* The foreign language requirement for the degree of Doctor of Philosophy is left to the individual department, division, or jointly administered program, subject to the approval of the Graduate College.

*Examinations.* The Graduate College requires two examinations, and a committee will be appointed for each. The first examination shall be called the preliminary and shall be an examination of the candidate's grasp of the field of his major (and minor) subjects. The second shall be an examination on the candidate's dissertation. The department may have additional requirements.

The committee for the preliminary examination shall consist of at least five persons representing the major and minor areas, one of whom may be from outside the department or from outside the University. Members of the com-



mittee will be appointed by the Dean of the Graduate College on recommendation of the department. The chairman and at least one other member must have full standing or its equivalent.

The preliminary examination shall be written, oral, or both at the discretion of the department. The timing is also at the discretion of the department. The recommendations of the department, including the action of the committee, shall be reported to the Graduate College. Part of the report will be a summary of the votes of the committee members. The total vote shall be pass, conditional (specified), or fail. A candidate may not be passed if he receives more than one vote of fail. When there is not unanimity the Graduate College will act as arbitrator. The Dean, in consultation with the department head and the committee chairman, may allow the candidate to be given a second examination at some later date. The second committee may consist of the same examiners. No more than two preliminary examinations may be given.

The dissertation committee shall follow the regulations outlined above except that the minimum membership shall be three, of which the chairman and one other member must have full standing or the equivalent. The candidate is admitted to the final examination upon recommendation of the major department.

*Thesis.* The Doctor of Philosophy is primarily a research degree and the candidate must demonstrate his capacity for independent research by the presentation of an original thesis on a topic within his major field of study. The subject of the thesis must be reported to the doctoral committee and to the Graduate College at the time of the preliminary examination. The candidate must register each term, except summer quarters, until he receives his degree. When the credit requirement is satisfied (144 quarter hours of courses and thesis research beyond the bachelor's degree), the student maintains his status as a candidate by registering for zero credit in thesis research (499). Candidates engaged in thesis research may find it desirable or expedient to publish prior to the conferring of the degree certain findings that later will be incorporated in the dissertation. In this case, appropriate acknowledgment of the earlier publication should be included in the dissertation. The Graduate College encourages such publication, but the thesis in its entirety may not be published before all degree requirements have been completed. Directions regarding the format of the thesis are given in the leaflet, "Instructions for Preparation of Theses," which may be obtained in the Graduate College office. The candidate must submit to the Graduate College office, no later than the date specified in the current calendar of the College, the original and first carbon copy (or two copies reproduced by an approved method) of his thesis and one typewritten copy of an abstract not exceeding 600 words. Each candidate who passes the final examination must pay a \$25.00 microfilm fee. This provides for microfilming the complete thesis, with one copy deposited in the University of Illinois library, and publication of the abstract in *Dissertation Abstracts*.

*Graduate Study by Seniors at the University of Illinois.* Upon recommendation of the department, an undergraduate student may be given graduate credit for graduate courses taken in his senior year, if credit for such courses is not to be applied toward the fulfillment of requirements for the baccalaureate degree.

## Tuition, Fees, and Other Charges

All students are assessed tuition and fees which are payable in full as part of registration. Arrangements to defer payment under special circumstances may be made with the Business Office. The amount of tuition and the service fee vary with the number of credit hours for which the student registers. Tuition (but not the service fee) also varies according to the resident or nonresident status of the student in the State of Illinois.

### Tuition and Fees

	Full Program		Partial Program			
	Range I Above 10 quarter hours		Range II From 6 to 10 quarter hours		Range III From 1 to 5 quarter hours	
	Resident	Non-Resident	Resident	Non-Resident	Resident	Non-Resident
Tuition (except those holding exemptions)	\$ 57	\$250	\$ 40	\$175	\$ 25	\$ 90
Service fee	32	32	24	24	14	14
Hospital-Medical-Surgical Insurance fee	7	7	7	7	7	7
Total	\$ 96	\$289	\$ 71	\$206	\$ 46	\$111

*Tuition and Fee Deposit.* The University requires a nonrefundable \$30 advance deposit, payable when an applicant receives notice of admission. This deposit reserves the applicant a place only in the session to which he has been admitted. It is applied to his tuition and fees for that quarter; it cannot be applied to any subsequent quarter should he fail to enter in the quarter to which he has been admitted.

*Residence Classification.* The residence classification of an applicant is determined on the basis of information given on his application and other credentials. Fees are assessed in accordance with this decision. If the student believes he has a legitimate cause for change of status, he may, by petition, on a form provided by the Office of Admissions and Records, request a change. Petitions

are considered within thirty days from the date designated in the official University Calendar as that upon which instruction begins for the academic period for which the fee is payable. However, if the nonresident fee was not assessed on or prior to that date, the claim for refund may be filed within thirty days after the nonresident fee was assessed and the student was given notice of its assessment. Tuition and fees will not be adjusted for that academic term if the petition is not filed within these time limits. Additional evidence to substantiate a request may be required. If the student expects to ask for a change of residence classification, it is advisable for him to request that the adjustment be made prior to the registration period.

In the event a student who claims he is a resident is dissatisfied with an adverse ruling of the Director of Admissions and Records, he may obtain a review of such decision by the Legal Counsel of the University by filing a written request with the Director of Admissions and Records within twenty days after he has been notified of the ruling.

Further information concerning residency may be secured from the Director of Admissions and Records. A brochure entitled *Regulations Governing Assessment of Resident or Nonresident Student Fees* is also available.

## Exemptions

A student may be exempted from one or more of the usual charges if he qualifies under the following conditions:

Tuition is waived for:

- (1) Holders of tuition-waiver scholarships.
- (2) All academic employees of the University or allied agencies on appointment for at least 25 percent but not more than 67 percent of full-time services.
- (3) All permanent nonacademic employees of the University or allied agencies on appointment for at least 25 percent of full time who register in University courses in Range II or III.
- (4) Holders of graduate tuition and fee waivers awarded by the Graduate College.
- (5) Holders of grants or contracts from outside sponsors which provide payments to cover the total costs of instruction.
- (6) Teachers and administrators who cooperate in the practice teaching program. (Exemption is allowed for each quarter of assignment within the same calendar year—September through August.)
- (7) Persons registered in noncredit seminars only.
- (8) University employees registered at the request of their departments in noncredit courses especially established to improve the work of the employee.
- (9) Academic staff members emeriti.

The nonresident portion of tuition (if the enrollee is subject to payment of tuition) is waived for:

- (1) All staff members (academic, administrative, or permanent nonacademic) on appointment for at least 25 percent of full time with the University or allied agencies.
- (2) The faculties of state-supported institutions of higher education in Illinois.



- (3) The teaching staff in the private and public elementary and secondary schools in Illinois.
- (4) The spouses and dependent children of those listed in items 1 and 2 above. (Dependent children are those who qualify as dependents for federal income tax purposes.)
- (5) Persons actively serving in one of the Armed Forces of the United States who are stationed and present in the State of Illinois in connection with that service.
- (6) The spouses and dependent children of those listed in item 5 above, as long as they remain stationed, present, and living in Illinois.

## Assessments and Exemptions

For fee assessment purposes, a staff appointment must require service for not less than three fourths of the term. This is interpreted as a minimum of nine weeks in a quarter. Staff tuition and fee privileges do not apply to students employed on an hourly basis in either an academic or nonacademic capacity or to persons on leave without pay.

For fee assessment purposes, a permanent nonacademic employee is defined as a person who has been assigned to an established, permanent, and continuous nonacademic position and who is employed for at least 25 percent of full time. University employees appointed to established Civil Service positions whose rate of pay is determined by negotiation, prevailing rates, or union affiliation are not considered as paid on an hourly basis and are entitled to the same tuition and fee privileges accorded other staff members under the regulations.

Any student who resigns his staff appointment, or whose appointment is cancelled before rendering service for at least three fourths of the term, becomes subject to the full amount of the appropriate tuition and fees for that term unless he withdraws from his University classes at the same time the appointment becomes void. Such students are not assessed tuition and fees for that term if they file clearance for graduation within one week after the appointment becomes void.

## Fees

*The Service Fee* is applied toward the operating expense of Chicago Circle Center, the financing of the Center building, and the cost of the Student Activities Program.

The service fee is waived for:

1. All staff members of the University or allied agencies who are appointed for at least 25 percent but not more than 67 percent of full time.
2. Holders of graduate tuition-and-fee waivers awarded by the Graduate College.
3. Students registered *in absentia*.
4. Students registered in courses taught off campus.
5. Holders of grants or contracts from outside sponsors if the service fee is charged to the contract or to grant funds.
6. Cooperating teachers and administrators described under *Exemptions*, item 6, page 19.
7. Persons registered in noncredit seminars only.



8. University employees registered at the request of their departments in noncredit courses especially established to improve the work of the employee.
9. Emeriti.

*The Course-Visitor-Auditor Fee* of \$15.00 is assessed all class visitors who are not in Range I in the tuition-and-fee schedule.

*The Late-Registration Fine* of \$15.00 is levied against all students who complete registration after classes have begun.

*The Hospital-Medical-Surgical Insurance Fee* is the same for all students, regardless of the number of hours for which they are enrolled or of their Illinois residence status. All students enrolled and in attendance at Chicago Circle are covered by a health insurance policy, for which they pay a fee of \$7.00 per quarter at registration. Eligible dependents of insured students (spouse and/or unmarried dependent children under nineteen years of age) may also be insured if the student makes application to the University Cashier (4th floor, University Hall) within the time specified by the insurance policy.

If a student withdraws from the University, he does not receive a refund since he remains insured for the balance of the quarter from which he withdrew. Special provisions exist for students to be covered by this insurance during the summer months, irrespective of their registration for that part of the year. For further information, consult the Insurance Office in Room 420, University Hall.

If a student presents evidence of insurance in force which provides him equivalent coverage, he may petition the University Insurance Office for a refund of this fee. Refunds are not made on any other basis. The student should also consult the Insurance Office about the time limit for such a refund petition.

*Transcript Fee.* A student is issued one transcript of his record without charge. For each additional transcript, a fee of \$1.00 is assessed.

## Refunds

Students who withdraw from the University or from a course are entitled to a refund of a portion of the tuition and fees if they have been paid under the following circumstances:

*On Withdrawal from the University:* The full amount of tuition and fees assessed, *except for a \$30 nonrefundable service charge*, is refunded to students who withdraw *within the first ten days* of instruction in a quarter. After the tenth day of instruction and before the middle of the quarter, one half of the amount assessed, *except for a \$30 nonrefundable service charge*, is refunded.

No refund is issued after midquarter.

No refund is issued if the total assessment was less than \$30 (for example, a student on a tuition-waiver scholarship.)

*On Withdrawal from a Course:* If such withdrawal results in a reduction in the student's program to a lower tuition and fee range, the full difference is refunded during the full-rebate period; half the amount of the difference is re-

funded when withdrawal occurs during the half-rebate period; no refund is made if withdrawal occurs thereafter. See the quarterly timetable for specific dates for each quarter.

*On Withdrawal by a Visitor-Auditor:* A full refund will be issued if the withdrawal is made within ten days after payment of fees. Thereafter, no refund will be made.

*On Withdrawal to Enter Military Service:* If withdrawal occurs during the first six weeks of instruction, the student is entitled to a full refund of his tuition and fees, less the Hospital-Medical-Surgical Insurance fee. If withdrawal to enter military service occurs between the fifth and eighth weeks of instruction, the student will receive a one-half refund of his tuition and fees (less the Hospital-Medical-Surgical Insurance fee). When the withdrawal occurs after the fifth week of instruction, under certain circumstances, the student may receive partial or full credit in some of the courses in which he is registered at the time of the withdrawal. Further information is available in the Graduate College, 2323 University Hall.

No refund of tuition and fees is made after the eighth week.

## **Assistantships, Fellowships, and Financial Aid**

Various types of financial assistance are available each year to promising students in all fields of study in the Graduate College. For the most part, the information in this section deals with aid administered by the University of Illinois. It should be noted, however, that there are also a number of nationally sponsored fellowships that provide support for graduate students for study either at the University of Illinois or elsewhere. Among these are the National Science Foundation fellowships and traineeships and the Woodrow Wilson fellowships. Other fellowships are offered through foundations, industrial concerns, and individuals. Further information and application procedures for nationally sponsored fellowships may be obtained by writing directly to the agency concerned or, in most instances, to the University department in which the student plans to major.

The University of Illinois directly administers five main types of financial aid for graduate students. These are: fellowships (including traineeships), assistantships, both in teaching and research, tuition and fee waivers, loans, and employment. Each type is described in the following sections.

## Fellowships

Fellowship stipends are gratuities awarded in recognition of scholarly achievement and promise. They enable a student to pursue his graduate studies and research without requiring him to render any service. The stipends of different fellowships vary, but with few exceptions they are currently not less than \$2,000 for the nine-month academic year. The fellow's stipend is legally regarded as a gift, not as compensation for services rendered, and is, therefore, exempt from income tax. Unless explicitly stated otherwise, all fellows whose appointments are administered by the Graduate College are exempt from tuition and fees. A fellow is required to pursue a full program of graduate study (at least 16 quarter hours per quarter) and may not engage in remunerative employment, other than a teaching assistantship for University fellows, without the permission of the Dean of the Graduate College.

*University Fellowships* are awarded on the basis of an all-University competition and are not restricted to any particular field of graduate study. University fellowships are for nine months and carry a stipend of not less than \$2,000 plus exemption from tuition and all regular fees except the Hospital-Medical-Surgical Insurance fee.

A student receiving a University fellowship is also eligible to accept a part-time teaching assistantship up to a maximum of one-quarter time. Under such an appointment, the fellow's basic stipend remains unchanged and tax-free, but the salary for teaching is subject to income tax. University fellows who also hold a teaching assistantship must carry full programs of graduate study (at least 16 quarter hours per quarter) unless expressly authorized by the Dean of the Graduate College to carry reduced programs. Students whose first interest is in teaching should so indicate in their applications.

*Industrial, Endowed, and Special Fellowships.* Various industrial firms, foundations, and private individuals have generously donated funds to support some special fellowships for graduate students at the University of Illinois. The stipends and supplemental allowances of these fellowships are not uniform, and most of them are restricted to students in particular areas of study. Further information may be obtained from the department in which the student plans to register.

*National Science Foundation Traineeships.* Under this program, grants are made directly to the participating institutions, which select promising individuals for full-time graduate study. Appointments may be made only from among citizens of the United States (or native residents of a United States possession) who are enrolled in programs leading to an advanced degree in the mathematical, physical, medical, biological, and engineering sciences, anthropology, economics, geography, the history and philosophy of science, linguistics, political science, psychology, and sociology. Also included are the interdisciplinary areas, which are comprised of overlapping fields among two or more sciences (for example, geochemistry, meteorology, and oceanography).

Trainees must devote full time to programs leading to advanced degrees and may be appointed for either nine or twelve months. A school may require or permit a trainee to include in his training program teaching which contributes to his academic progress.



The basic stipend for a twelve-month award is \$2,400 for those at first-year level, \$2,600 for those at intermediate-year level, and \$2,800 for those at terminal-year level. An allowance of \$500 is granted for each dependent. For nine-month awards, the allowance will be prorated. Inquiries concerning traineeships should be directed to the appropriate department of the University.

**Assistantships**

The various departments of the University employ graduate students as either teaching assistants or research assistants. The duties of a teaching assistant usually involve such activities as classroom instruction, supervision of a laboratory section, the guidance of discussion sections, and paper grading. Research assistants participate in research activities under the supervision of University faculty members. In some instances the work of a research assistant may be related to his thesis research; in others it may be entirely different. Although most research assistantships are awarded to graduate students who have completed one or more quarters of graduate work at the University of Illinois, new students are eligible for such appointments. Every assistant is paid a salary for services rendered, and, under present ruling, this salary generally is subject to income tax.<sup>1</sup> Assistants holding more than quarter-time appointments are normally not permitted to carry full programs of graduate study during the period of their appointments.

Nature of Appointment	Maximum Registration per Quarter	Expected Clock Hours of Service per Week
Quarter Hours		
Full time	4	37½
Three-fourths time	8	29
Two-thirds time	9	25½
One-half time	12	19
One-third time	15	12½
One-quarter time	16	9½

Those whose appointments range from 25 to 67 percent are exempt from tuition and all fees except the Hospital-Medical-Surgical Insurance fee. The above table lists the provisions of various assistantships. Applications may be made directly to the relevant University department.

**Tuition and Fee Waivers**

A graduate tuition and fee waiver provides exemption from tuition and all incidental fees (except for the Hospital-Medical-Surgical Insurance fee) for the academic year and the preceding or following summer quarter. To hold these awards students must be in residence and must register for at least twelve hours per quarter during the academic year, including the summer quarter. They may, however, accept part-time or incidental employment not to exceed twenty hours a week either within or without the University.

<sup>1</sup>The District Director of Internal Revenue has ruled that under certain conditions income tax need not be withheld from remuneration paid to research assistants engaged in thesis research.

Veterans who are admissible to a graduate program and who meet certain residence requirements may be eligible for exemption from tuition and certain fees under the state statute covering Military Scholarships. Further information may be obtained from the Office of Financial Aid, 809 University Hall.

## **How to Apply**

Application materials and instructions may be obtained from the Graduate College or from any graduate department. Only one application form is needed to apply for any of the types of financial aid listed.

To be considered for a University fellowship beginning in June or September, the application must be filed with the major department no later than the preceding February 15. Applications for tuition and fee waivers and assistantships are accepted after that date, but applicants for such appointments are strongly urged to submit their applications as early as possible since many departments offer their assistantships at the same time they consider applications for fellowships.

## **Announcement of Fellowship Awards**

Fellowship awards are announced by the Graduate College on or about April 1. Recipients are expected to accept or decline by April 15. The University of Illinois adheres to the following resolutions adopted by the members of the Association of American Universities and a number of other graduate schools in North America:

"In every case in which a graduate assistantship, scholarship, or fellowship for the next academic year is offered to an actual or a prospective graduate student, the student, if he indicates his acceptance before April 15, will still have complete freedom to reconsider his acceptance and to accept another fellowship, scholarship, or graduate assistantship. He has committed himself, however, not to resign an appointment after this date unless he is formally released from it."

## **Loans**

*Long-Term Loan Funds* are available to those students who have a demonstrated financial need. Loans approved by the Director of Financial Aid are subject to the availability of funds, and no commitment is made until all financial information has been reported. The signature of a qualified endorser or satisfactory collateral is required for all long-term loans. Exceptions to this requirement may be made by the terms of the loan fund or may be waived in meritorious cases by the Director of Financial Aid. Each application must be signed by the applicant's department chairman.

Students must be in good standing before an application is accepted for processing. If loans are made over a three-quarter period, the student must remain in good standing to receive a second advance. Any exceptions to this rule must be requested from the Office of Financial Aid. The Office of Financial Aid maintains a list of loan sources, such as private foundations, church-related sources, and bank sources in addition to those below. This information will be provided upon request.

*University Loans.* A student may borrow from the University Loan Fund an amount not to exceed \$1,000 per year or a total of \$2,500. He must begin to repay his loan, at an interest rate of 3 percent annually, within four months after leaving the University, and he has up to four years in which to make complete repayment.

*National Defense Education Act Loans.* A graduate student may borrow money from funds provided to the University under Title II of the National Defense Education Act. The limit is \$2,500 per year, to a total of \$10,000. He must begin to repay his loan, at an interest rate of 3 percent annually, nine months after he has ceased to pursue a full-time course of study at the University, and the entire loan must be repaid within ten years after repayment begins.

It should be noted, however, that up to 50 percent of a National Defense Education Act loan will be cancelled if the borrower serves as a full-time teacher in a public or nonprofit private school in the United States. This applies to elementary or secondary schools, as well as to institutions of higher education. Such cancellation will be at the rate of 10 percent of the loan for each academic year of such service. Teaching in designated "hardship" areas carries loan cancellation up to 100 percent.

Co-signers are not required for NDEA loan funds.

*United Student Aid Fund Loans.* A graduate student may borrow up to \$2,000 per year, to a total of \$4,000. The amount of the loan will be determined on an individual basis. No notes under this plan may bear more than 6 percent simple interest. Repayments begin the first day of the fifth month after graduate education is completed. The normal repayment period is thirty-six months, but larger loans may be paid over periods ranging up to fifty-four months. Monthly installments may not be less than \$30.

*Illinois State Guaranteed Loans.* The Illinois General Assembly has authorized an Illinois loan program to guarantee student loans made by commercial lenders to legal residents of the State of Illinois. An eligible student may borrow from a minimum of \$300 to a maximum of \$1,500. It is expected that a student will borrow only once during the academic year. Repayment does not begin until the student either graduates or ceases full-time study. A loan will not be granted in an amount which exceeds the established educational expenses at the eligible college selected by the student, minus other scholarship or loan assistance. Applications may be secured from the Office of Financial Aid, 809 University Hall.

*Short-term Emergency Loans.* Students may request short-term emergency loans from \$5 to \$100. The loan must be paid within forty-five days or by the end of the quarter, whichever date is earlier. Request forms may be obtained from the Offices of the Dean of Men or Dean of Women, 827 University Hall.

## **Employment**

The Student Employment Office, located on the eighth floor of University Hall, welcomes the opportunity to counsel students about employment. The office also offers students a library of job-reference materials, job listings, inter-



views, and referrals for employment to University departments and to agencies and business firms in the Chicago area. Securing a position through proper application and retaining that position through good work is, of course, the responsibility of the individual.

## Campus Facilities and Student Services

### Library

The University Library provides those books, periodicals, and related materials required to meet the instructional needs of the student. Library collections necessary for keeping scholars informed in their respective fields are currently in a stage of rapid growth.

The Library has been a depository for United States government documents since 1957. The map collection contains topographical, army, and state high-way maps. Numerous materials are available in microfilm or microprint.

*The Department of Special Collections* administers the Library's collections of maps and rare books and a growing collection of manuscripts. Included are materials in the fields of social welfare, politics, and labor, as well as those relating to various religious and ethnic groups in Chicago. Among these materials are the records of the Chicago Urban League, the Juvenile Protective Association, the Illinois Humane Society, the Chicago League of Women Voters, and the Metropolitan Housing and Planning Council of Chicago. The Jane Addams Memorial Collection, located in the restored Hull Mansion on the Chicago Circle campus, contains books, manuscripts, and memorabilia dealing with Miss Addams' life and work and with the social welfare movement. All such materials are available to faculty and graduate students for research.

*The Urban Historical Collections* contain several thousand items related to urban affairs, Negro history, social settlement work, Hull House, Chicago politics and ethnic history, all of which are available for research not only to established scholars but to graduate students in urban-related disciplines.

A detailed outline of the general collections and suggestions for effective use of the library will be found in the *Library Handbook*, copies of which are available at all Library service desks.

### The Computer Center

A grant from the National Science Foundation has enabled the University greatly to expand its computing resources on the Chicago Circle Campus, and in September, 1967, an IBM 360 model 50 computer with 262,544 bytes of core storage was placed in operation. Facilities have subsequently been expanded to include bulk core storage, increased disk capacity, and a process control computer for on-line monitoring of laboratory experiments.

The staff of the Computer Center teach courses in programming and numerical analysis, in cooperation with the Department of Mathematics and the College of Engineering. The staff also assist other departments in utilizing the equipment for both teaching and research throughout the campus.



## Office of Instructional Resources

The Office of Instructional Resources, housed in the Library, is the agency responsible for planning, developing, and, when appropriate, administering technological aids to instruction and for advising and assisting the faculty in using these aids to improve the effectiveness and efficiency of instruction.

The Programmed Instruction Division works with faculty members in developing programmed instruction for academic courses and in locating and using programmed materials from outside sources. The Television Division produces and distributes instructional television presentations and supports other television applications in teaching. The Audio-Visual Division operates a media information and projection service and a professional facility for making slides, overhead transparencies, and handouts.

## Laboratory Facilities

At present the departments of Biological Sciences, Chemistry, Geological Sciences, Physics, and the Engineering Sciences occupy research facilities in the Science and Engineering Laboratories, the twin buildings at the south end of the main campus. By the fall of 1969 the first four departments are expected to occupy, in addition, the new science and engineering center between Taylor Street and Roosevelt Road to the south of the present laboratories. This set of buildings affords considerable space for housing specialized equipment, the details of which are available from the departments concerned.

*The Phonetic-Linguistic Research Laboratory* contains recording and specialized equipment patterned after a similar installation at the University of Hamburg.

*The Behavioral Sciences Center*, now under construction (to be completed in 1969), will contain research laboratories for demography, sociology, and psychology.

## Facilities within the City

The University of Illinois Medical Center departments cooperate with the Chicago Circle Departments of Biological Sciences, Chemistry, Psychology, and Sociology in encouraging joint graduate study, seminars, and the use of the Medical Library.

The Newberry Library (social sciences and humanities), the Crerar Library (science and technology), the Art Institute, the Field Museum of Natural History, the Museum of Negro History, the Library of International Relations, the Center for Research Libraries, the Chicago Historical Society, and the Chicago Municipal Reference Library are important nearby institutions for research.

## Student Affairs

The *Student Handbook*, issued each fall, presents a wide variety of information about services available to students and regulations governing student life. Some of the services immediately relevant to many graduate students are described below.

*Student Counseling Service.* Interviews and psychological testing are available to all students and provide the basis for vocational or personal counseling by a professional staff.

*University Health Service.* The University provides clinic services for both preventive medicine and treatment. The cost of most medical expenses that cannot be assumed by the Health Service is covered by the student Hospital-Medical-Surgical Insurance, supervised by the Insurance Division of the Business Office, at a cost to the student of \$7.00 per quarter.

Beds are provided for the temporary day care of sick or injured students. The University does not provide hospital care for its students, the large majority of whom are from families living in the Chicago area; hence, cases requiring bed care can be referred to the student's family doctor and to hospitals of the community.

*Coordinator of Foreign Student Affairs.* Foreign students are assisted in evaluating their abilities and interpreting regulations applicable to them. This service includes assistance on problems of extension of stay, employment, border crossing, the details of maintaining legal status, housing, and understanding of the American way of life.

*Speech Clinic.* Students who wish assistance in correcting speech difficulties, including those arising from foreign accents, hearing deficiencies, and vocal or articulatory problems, should avail themselves of the services of this clinic. There are no fees for these services. The clinic is located in 202 Grant Hall.

## **The Departments**

**Note:** All departmental admission and degree requirements are in addition to those of the Graduate College. Students must familiarize themselves with *both* sets of requirements.

### **BIOLOGICAL SCIENCES**

#### **Professors**

John O. Corliss, Head of the Department; Sidney F. Glassman, Bernard Greenberg, Kenneth M. Madison, Charles A. Reed, Albert S. Rouffa, William Sangster, Max C. Shank, Rolf Singer (Visiting), Eliot B. Speiss, Theodore J. Starr, Associate Head.

#### **Associate Professors**

Donald A. Eggert, Helene N. Guttman, Elmer B. Hadley, Jacques Kagan, Donald A. Levin, Ellis B. Little, Halina J. Presley, David Shomay, Charles N. Spirakis, Thomas N. Taylor, Robert B. Willey.

#### **Assistant Professors**

Louise E. Anderson, David Bardack, James A. Bond, Howard E. Buhse, Jr., Manuel A. Goldman, Darrel L. Murray, John A. Nicolette, Thomas W. Seale, Phebe VanValen, Marvalee H. Wake, Ruth L. Willey.

The Department of Biological Sciences offers work leading to the degree of Master of Science in the following areas of specialization: genetics and development; systematics, evolution, and ecology; and physiology and morphology.

## Admission Requirements

*Grade-Point Average:* At least 3.75 (5.00=A) for the last 90 quarter hours of undergraduate study. A student whose average is between 3.50 and 3.75 may petition for consideration.

*Hours:* 30 quarter hours in biological sciences excluding 100-level courses and including genetics and cellular, or general, physiology or the equivalent; one year in each of the following: chemistry (including organic), mathematics, and physics. Deficiencies must be made up early in the student's residence.

## Degree Requirements

*Hours:* 48 quarter hours of approved graduate work of which at least 18 must be in 400-level courses.

*Thesis:* Optional; satisfactory performance on the oral comprehensive examination and 4 to 12 quarter hours of Biological Sciences 493 (Problems in Modern Biology) may serve in lieu of the thesis. If the candidate elects a thesis, a maximum of 16 quarter hours in Biological Sciences 499, the thesis and research course may be credited.

*Comprehensive Examination:* Oral; the candidate must demonstrate competence in two of the three areas of specialization and familiarity (satisfiable by A or B grades in approved courses) with the third. Candidates electing a thesis take an oral examination, administered by a committee including members of his advisory committee, which tests the candidate on his general biological knowledge and on the purpose and content of his thesis.

Degree candidates are urged to achieve competence in at least one modern foreign language and to register for courses in calculus, statistics, and biochemistry.

## Courses for Graduate Students

401. **Foundations of Biological Thought. 4 hours.** Presentation and analysis of some of the fundamental concepts of the mainstreams of biological thought.
402. **Patterns of Biological Enquiry. 4 hours.** Contemporary and developing ideas in biology, utilizing blocks of integrated research papers to analyze the functioning of selected ideas as they influence the design, execution, and interpretation of research problems. Prerequisite: BioS. 401.
403. **Enquiry Processes in the Classroom. 4 hours.** The insights derived from BioS. 401 and 402 are used in preparing inquiry oriented materials for presentation in the classroom. Prerequisite: BioS. 402.
404. **Methods in Cellular Physiology 1. 2 to 5 hours.** Analytical techniques and instrumentation used in microbiology, cell biology, and physiology. Practical and theoretical problems associated with these techniques will be considered.



Prerequisites: Cellular biodynamics or equivalent, and biochemistry or concurrent registration in biochemistry.

- 406. Biological Ultrastructure. 5 hours.** Discussion, instrumentation, and special topics in fine structure of plant and animal cells and cell products. Prerequisites: BioS. 261 and 309, organic chemistry, and consent of the instructor.
- 407. Principles of Cell and Tissue Culture. 5 hours.** Methods for primary isolation of plant and animal tissue and subsequent cultivation. Uses of cells in culture as experimental tools. Prerequisites: BioS. 250 and 261.
- 411. Discussions in Paleobiology. 1 hour.** May be repeated for credit. A consideration of selected topics and current research literature in paleobiology. Prerequisite: Consent of the instructor.
- 415. Principles of Morphogenesis. 4 hours.** Analysis of factors controlling growth and differentiation in unicellular and multicellular organisms. Prerequisites: BioS. 240 and 313 or consent of the instructor.
- 420. Advanced Vertebrate Paleontology. 4 hours.** Same as Geol. 420. Given as three different courses. May be repeated twice for credit. Advanced treatment of the functional morphology, paleoecology, and phylogeny of the various vertebrate groups: fishes, amphibians and reptiles, mammals. Prerequisites: BioS. 282 and 318.
- 422. Physiological Ecology of Plants. 4 hours.** Physiological investigation of climatic and edaphic differentiation; emphasis on the ecophysiological adaptations of species to their environments. Prerequisites: BioS. 315, 324, or 380, and one quarter of plant physiology.
- 423. Discussions in Ecology and Behavior. 1 hour.** May be repeated for credit. A consideration of selected topics, current literature, and recent advances in ecology. Prerequisite: Consent of the instructor.
- 425. Plant Anatomy. 4 hours.** Examination of the internal structure of vascular plants; emphasis on structure and function. Lecture and laboratory. Prerequisite: Consent of instructor.
- 426. Biochemical Systematics. 4 hours.** Analysis of the utilization of comparative biochemical data in determining evolutionary relationships among groups of plants and animals. Prerequisites: BioS. 345 and 353.
- 438. Experimental Plant Systematics. 4 hours.** Evolutionary mechanisms and pathways in higher plants; analysis of genetic, chromosomal, morphological, and physiological properties of natural assemblages at and below the species level of divergence. Lecture and laboratory. Prerequisites: BioS. 342 and 349.
- 440. Seminar in Genetics. 3 hours.** Discussion of research literature in the field. Student topics assigned. Prerequisites: BioS. 240 and consent of the instructor.
- 442. Problems in Population Genetics. 4 hours.** Lecture and discussion of research literature in the field. Prerequisites: BioS. 343 and 344.
- 445. Discussions in Systematics and Evolution. 1 hour.** Consideration of current literature and of recent advances in the field of systematic biology. Prerequisite: Consent of the instructor.
- 450. Topics in Microbial Physiology. 4 hours.** Modern contributions to microbiology, including the ultrastructure of the bacterial cell, metabolism and control mechanisms, bacterial genetics and cell-viral systems. Lecture and laboratory. Prerequisite: BioS. 350.

- 455. Topics in Molecular Biology. 3 hours.** May be repeated for credit. Selected topics emphasizing molecular studies involved in diverse biological areas as virology, genetics, immunology, photobiology, pharmacology, exobiology. Prerequisites: BioS. 240, 250, 261, and consent of the instructor.
- 470. Comparative Animal Physiology I. 4 hours.** Study of selected adaptive mechanisms of animals to the stresses of the environment in their several major kinds of habitat. Emphasis on invertebrates. Lecture, laboratory, discussion. Prerequisites: BioS. 363 and 364 or consent of the instructor.
- 471. Comparative Animal Physiology II. 4 hours.** Study of selected adaptive mechanisms of animals to the stresses of the environment in their major kinds of habitat. Emphasis on invertebrates. Lecture, laboratory, discussion. Prerequisite: BioS. 470 or consent of the instructor.
- 472. Experimental Animal Physiology. 4 hours.** May be repeated once for credit. Selected topics in experimental surgery and pharmacodynamics. Prerequisite: BioS. 363 or 364.
- 486. Advanced Invertebrate Zoology. 4 hours.** Selected topics in currently advancing areas of descriptive and experimental invertebrate zoology. Emphasis on recent comparative research in such areas as behavior, embryogenesis, circadian rhythms, and ecological adaptations. Lecture and laboratory. Prerequisites: BioS. 385 or 470 and consent of the instructor.
- 489. Advanced Protozoology. 4 hours.** Consideration of selected topics in modern protozoological research. Prerequisite: BioS. 389.
- 490. Problems in Vertebrate Morphology. 4 hours.** Feeding and locomotory mechanisms of selected vertebrates. Dissection, experimentation, and seminar presentation of analyzed results. Laboratory and discussion. Prerequisite: BioS. 393 or the equivalent.
- 493. Problems in Modern Biology. 2 to 4 hours.** May be repeated for credit. Not to be used for thesis research. Guided study of selected topics with research potential in specific fields of advanced modern biology. Prerequisite: Consent of the instructor.
- 495. Graduate Seminar. No credit.** Thesis presentation by advanced students; occasional seminar by staff and invited speakers. Required of graduate students every quarter.
- 499. Thesis Research. 0 to 16 hours.** Work in a number of fields offered under the direction of faculty members with appropriate graduate standing.

### **Courses for Graduate and Advanced Undergraduate Students**

- 300. Seminar. 0 to 1 hour.** Faculty and visiting biologists discuss results of their research programs before staff and students at weekly meetings. Attendance of majors at all meetings is strongly encouraged.
- 304. Instrumentation in Cell and Tissue Study. 3 hours.** Advanced cytology; emphasis on instrumental methods. Modern biophysical techniques. Prerequisites: Phys. 102, Chem. 134, BioS. 261, and concurrent registration in BioS. 309; or consent of the instructor.
- \*305. Biostatistics. 3 hours.** A training course, for future professional biologists, in those statistical methods most useful in the design and analysis of biological investigations. Lecture and laboratory. Prerequisite: Consent of the instructor.

\*Approval pending.

307. **Biological Methods for Teachers. 2 hours.** The investigation of methodological subjects, conducted primarily as a practicum; emphasis on the development of competencies.
309. **Cytology. 3 hours.** Structure and functions of cells as revealed through historical development and modern research techniques. Lecture.
313. **Developmental Biology. 4 hours.** Principles governing growth and differentiation at molecular, fine structural, cellular, and organismic levels. Lecture and laboratory.
315. **Principles of Ecology. 3 hours.** Composition and distribution of biotic communities, plant and animal; emphasis on the interplay of physical and biological factors of the environment. Prerequisite: Concurrent registration in BioS. 324 or 380.
316. **Invertebrate Paleontology. 4 hours.** Same as Geol. 316. Phylogeny, morphology, and ecology of the fossil invertebrates. Prerequisites: BioS. 218 and consent of the instructor.
318. **Vertebrate Paleontology. 4 hours.** Same as Geol. 318. Phylogeny, morphology, and ecology of the fossil vertebrates. Prerequisite: Consent of the instructor.
319. **Paleobotany. 4 hours.** Structure, phylogeny, and stratigraphic distribution of representative fossil plants. Lecture, laboratory, and field trips.
320. **Field Botany. 5 hours.** Flora and vegetation of the Chicago region. Lecture, laboratory, field trips. Prerequisite: BioS. 220 or equivalent.
321. **Plant Geography of North America. 4 hours.** Ecological and systematic treatment of vegetation regions and principal subdivisions with emphasis on environmental factors and floras. Prerequisite: BioS. 220 or 315.
324. **Plant Ecology Laboratory. 2 hours.** Special attention to vegetation and environment of the Chicago region. Laboratory and field trips. Prerequisite: Concurrent registration in BioS. 315.
328. **Plant Physiology I. 5 hours.** Plant relations to water and solutes; translocation; inorganic plant nutrition; photosynthesis; respiration. Lecture and laboratory.
329. **Plant Physiology II. 5 hours.** Intensive study of the metabolism of carbon and nitrogen compounds and the physiology of growth and development. Lecture and laboratory. Prerequisite: BioS. 328 or consent of the instructor.
331. **Human Evolution. 4 hours.** Phylogeny of the primate order and the problems of speciation; particular emphasis on the relative roles of culture and nature as selective forces in human evolution.
333. **Morphology of Vascular Plants. 4 hours.** The structure, reproduction, and evolutionary history of representative vascular plants, including psilopsids, lucopsids, sphenopsids, ferns, gymnosperms, and angiosperms. Lecture and laboratory. Prerequisite: One year of biological sciences.
342. **Cytogenetics. 4 hours.** Chromosomal phenomena involved in the mechanics of genetics, structure of genetic material, and the role chromosomal variation plays in the evolution of races and species. Lecture and laboratory. Prerequisite: BioS. 240.
343. **Population Genetics. 3 hours.** Genetic dynamics for animal, plant, and human populations: mating systems, selection, sampling, and mutation. Lecture and



recitation. Prerequisites: BioS. 240, Math. 130, and credit or concurrent registration in statistics; or consent of the instructor.

- 344. Experimental Population Genetics. 3 hours.** Discussion of experimental and field empirical studies estimating genetic parameters, influence of selection, and other evolutionary forces on genotypes in populations. Lecture, laboratory, and discussion. Prerequisite: BioS. 343.
- 345. Systematics and Evolution. 3 hours.** Consideration of principles and interrelationships; basic analysis of evolutionary mechanisms; rationale for classification systems; nature of taxonomic characters. Lecture and discussion. Prerequisite: BioS. 240.
- 347. Physiological Genetics. 5 hours.** Consideration of heredity at the biochemical level, with particular reference to gene duplication, mutation, genetic control of protein synthesis, and genetic regulatory mechanisms. Lecture and laboratory. Prerequisites: BioS. 240 and Chem. 350.
- 349. Evolutionary Theory. 3 hours.** Analysis of evolutionary mechanisms in plants and animals; variation and differentiation in populations and species; origins of superspecific taxa. Prerequisites: BioS. 240, 315, and 345.
- 350. Advanced Microbiology. 5 hours.** Modern contributions to the cellular anatomy, physiology, and genetics of microorganisms. Lecture and laboratory. Prerequisites: BioS. 250 or 261 and credit or registration in biochemistry. Calculus is strongly recommended.
- 353. Chemical Biogenesis. 3 hours.** Biosynthesis of important biological compounds. Lecture and discussion. Prerequisite: Chem. 134 or 234.
- 356. Mycology. 4 hours.** Analysis of the morphology, physiology, and genetics of fungi, as related to the taxonomy and phylogeny of fungi. Lecture and laboratory.
- 359. Neuroanatomy. 3 hours.** An introduction to the central nervous system using a programmed text and supplementary material in the form of visual aids and outside readings. Prerequisite: Consent of the instructor.
- 361. Macromolecules of Biological Importance. 5 hours.** Study of the nucleic acids and proteins; emphasis on their roles in the replication of genetic material. Lecture and laboratory. Prerequisites: A course in organic chemistry and consent of the instructor.
- 363. Animal Physiology I. 5 hours.** The role of the digestive, circulatory, respiratory, and osmoexcretory systems in the maintenance of organismic homeostasis. Emphasis on vertebrates. Lecture and laboratory. Prerequisite: BioS. 261.
- 364. Animal Physiology II. 5 hours.** The role of the muscular, sensory, nervous, and endocrine systems in the maintenance of organismic integration. Emphasis on vertebrates. Lecture and laboratory. Prerequisite: BioS. 261.
- 377. Endocrinology. 5 hours.** The animal hormones in the control of integration, homeostasis, growth, and development. Lecture and laboratory. Prerequisite: BioS. 364.
- 380. Animal Ecology Laboratory. 2 hours.** Population and community assemblages of the Chicago region. Laboratory and field trips. Prerequisite: Concurrent registration in BioS. 315.
- 382. Environmental Conservation. 3 hours.** Applied ecology of use of renewable natural resources; special emphasis on biotic problems of land, water, and



air management; pollution, population increase, multiple-use concept, and land ethics. Lecture and field trips. Prerequisites: BioS. 315 and 324 or 380.

- 384. Invertebrate Zoology I. 5 hours.** Comparative study of structure, development, behavior, classification, and evolution of the lower invertebrate groups. Lecture and laboratory.
- 385. Invertebrate Zoology II. 5 hours.** Comparative study of structure, development, classification, and evolution of the higher invertebrate groups exclusive of arthropods. Lecture and laboratory. Prerequisite: BioS. 384.
- 388. General Entomology. 5 hours.** An introduction to the morphology, physiology, classification, behavior, and evolution of insects. Lecture and laboratory. Prerequisite: 2 years of biological sciences.
- 389. Principles of Protozoology. 5 hours.** Introduction to the comparative morphology, physiology, and systematics of the protozoa, including discussion of advances in major areas of current research. Lecture and laboratory.
- 393. Functional Animal Morphology. 4 hours.** Functional analysis of selected invertebrate and vertebrate organ systems applied to problems of comparative structure, adaptation, and phylogeny. Lecture and laboratory. Prerequisite: Consent of the instructor.
- 395. Zoogeography. 3 hours.** Examination of the present distribution of animals and discussion of climate, physiographic area, and paleozoologic history as they affect the development of major faunal areas and island populations. Trips to museums, zoos, and aquariums.

## CHEMISTRY

### Professors

William F. Sager, Head of the Department; Bernard J. Babler; Joseph H. Boyer, Chui F. Liu, Roy Huitema, Charles K. Hunt, Robert M. Moriarty, Jan Rocek, Robert I. Walter.

### Associate Professors

Thomas H. Brown, Richard L. Carlin, Jacques Kagan, J. Victor Mansfield, Samuel Schrage.

### Assistant Professors

Benedict W. Bangerter, Ronald J. Baumgarten, Richard P. Burns, Dolan H. Eargle, Cynthia J. Jameson, Rosalind A. Klaas, Florence C. Klee, Leonard Kotin, Yecheskel Rasiel, Tsu-Chia Shieh, Milton Yusem, Robert F. Zahrobsky.

### Instructors

Elaine P. Z. Herzog.

Work toward the Master of Science and Doctor of Philosophy degrees is offered in inorganic, organic, and physical chemistry.

### Admission Requirements

Applicants must have fulfilled the usual course requirements leading to a bachelor's degree with a major in chemistry and have a 4.0 grade-point average

in mathematics and science courses. Students with lower averages may apply and will be considered on an individual basis. Students who have majored in fields other than chemistry may be admitted to graduate study in chemistry on an individual basis.

## **Degree Requirements**

### **Master of Science**

*Hours:* 48 quarter hours, of which 32 must be within the Department of Chemistry. The remaining 16 may be selected from the offerings of other departments on the basis of their relevance to a particular area of interest. Course work in other departments will be strongly recommended when it is judged advisable for the student's best professional development. At least 16 quarter hours must be taken at the 400 level, of which 12 must be selected from the course offerings of the Department of Chemistry.

*Thesis:* Optional; up to 18 quarter hours of thesis research may be credited, subject to the approval of the department.

### **Doctor of Philosophy**

Students must, in addition to satisfying the general requirements of the Graduate College, pass a set of departmental cumulative examinations. The only specific courses required of all candidates are Chemistry 404, 405, and 406, which represent a foundation for all areas of specialization. All other formal course work is determined, with the advice of the department, according to its relevance to the student's field of interest.

All Ph.D. degree candidates are also required to participate in undergraduate teaching.

*Thesis:* Candidates must prepare a thesis based upon original research carried out under the direction of a qualified member of the department and approved by an examination committee.

All candidates must meet the departmental foreign language requirement.

Prospective candidates may obtain detailed information concerning all requirements on application to the Department of Chemistry.

### **Courses for Graduate Students**

- 404. Quantum Mechanics. 4 hours.** Exact solution of the Schrodinger equation for simple systems; variational principle; approximation methods in complex systems; effects of electric and magnetic fields. Required of all Ph.D. students in chemistry.
- 405. Molecular Spectroscopy. 4 hours.** Analysis and interpretation of molecular spectra, including electronic, vibrational, magnetic resonance and Mossbauer spectra. Required of all Ph.D. students in chemistry.
- 406. Chemical Applications of Group Theory. 4 hours.** Introduction to the use of group-theoretical methods in the analysis of spectroscopic problems; ligand and crystal field theory; molecular orbital calculations. Required of all Ph.D. students in chemistry. Prerequisite: Chem. 405.
- 412. Special Topics in Inorganic Chemistry. 2 to 4 hours.** Lectures on topics not represented in regularly scheduled courses.

413. **Physical Methods of Inorganic Chemistry. 3 hours.** Application of physico-chemical methods to problems in inorganic chemistry.
414. **Advanced Inorganic Laboratory. 2 to 4 hours.** Experimental methods in synthesis and study of inorganic compounds. Prerequisite: Graduate standing.
415. **Complex Inorganic Compounds. 4 hours.** Stereochemistry, reactions, and theory of bonding of coordination compounds. Prerequisite: Graduate standing.
432. **Special Topics in Organic Chemistry. 4 hours.** Discussion of topics of current interest. Prerequisite: Consent of the instructor.
433. **Special Topics in Reaction Mechanisms. 4 hours.** Theory and techniques in specialized areas in reaction mechanisms. Prerequisite: Chem. 362 or the equivalent.
434. **Physical Methods in Organic Chemistry. 4 hours.** Application of infrared, ultraviolet-visible, magnetic resonance, electron spin resonance, and mass spectrometry and optical rotatory dispersion in organic chemistry. Prerequisite: Chem. 405.
435. **Advanced Organic Synthesis. 4 hours.** Discussion and laboratory work involving special techniques in organic synthesis. Prerequisite: Credit or registration in Chem. 434.
436. **Chemistry of Natural Products I. 4 hours.** Discussion of the more important groups of natural products, including their structure determination, synthesis, and biogenetical relationships. Offered alternate years. Prerequisite: Chem. 235.
442. **Special Topics in Physical Chemistry. 2 to 4 hours.** Lectures and reading in areas not normally treated in standard courses. Discussions of topics of current interest.
443. **Special Topics in Chemical Kinetics. 2 to 4 hours.** Theory and techniques in specialized areas of chemical kinetics. Prerequisite: Chem. 349 or the equivalent.
444. **Statistical Mechanics I. 4 hours.** Statistical models of systems in thermodynamic equilibrium. Offered alternate years. Prerequisite: Chem. 349.
445. **Statistical Mechanics II. 4 hours.** Statistical models of the liquid state and nonequilibrium processes. Prerequisite: Chem. 444.
446. **Quantum Chemistry I. 4 hours.** Treatment of complex atoms and molecular systems. Hartree-Fock calculations and other methods; interaction of radiation matter. Prerequisite: Chem. 406.
447. **Quantum Chemistry II. 4 hours.** Continues Chem. 446. Prerequisite: Chem. 446.
448. **Quantum Chemistry III. 4 hours.** Continues Chem. 447. Prerequisite: Chem. 447.
461. **Synthetic Methods of Organic Chemistry I. 4 hours.** Discussion of methods used in organic syntheses; introduction and modification of functional groups, methods of selective group protection, stereospecific processes, recent examples of applications.
462. **Synthetic Methods of Organic Chemistry II. 4 hours.** Continues Chem. 461. Prerequisite: Chem. 461.
499. **Thesis Research. 0-16 hours.** Prerequisite: Approval of the department.



## Courses for Graduate and Advanced Undergraduate Students

- 315. Inorganic Chemistry. 4 hours.** Lectures and assigned readings in structural inorganic chemistry, inorganic reaction mechanisms and techniques, and the nature of the coordinate bond. Prerequisite: Chem. 342 or the equivalent.
- 321. Chemical and Instrumental Analysis I. 4 hours.** Chemical and instrumental methods of analysis and their application to the quantitative study of chemical reactions. Prerequisites: Chem. 235 and credit or registration in Chem. 343 or the equivalent.
- 322. Chemical and Instrumental Analysis II. 3 hours.** Continues Chem. 321. Prerequisite: Chem. 321.
- 338. Systematic Identification of Organic Compounds. 3 hours.** Primarily a laboratory course; chemical, physical, and spectroscopic methods are used to separate, purify, and identify organic compounds. Prerequisite: Chem. 237.
- 339. Organic Synthesis. 2 to 4 hours.** Discussion and laboratory work involving special techniques in organic synthesis. Prerequisite: Chem. 237 or the equivalent.
- 340. Physical Chemistry I. 3 hours.** Credit is not given for both the Chem. 380-382 sequence and the 340-341-342 sequence. Introduction to the study of chemical principles. Prerequisites: Chem. 119 or 121, credit or registration in Math. 133, and one year of college physics.
- 342. Physical Chemistry II. 3 hours.** Continues Chem. 340. Prerequisite: Chem. 340.
- 343. Physical Chemistry Laboratory II. 2 hours.** Continues Chem. 341. Prerequisites: Chem. 341 and concurrent registration in Chem. 342.
- 344. Physical Chemistry III. 3 hours.** Continues Chem. 342. Prerequisite: Chem. 342.
- 348. Thermodynamics. 4 hours.** Lectures and assigned readings on thermodynamics; applications to chemical systems. Prerequisite: Chem. 344.
- 349. Statistical Thermodynamics. 4 hours.** Introduction to statistical mechanics and application to equilibrium thermodynamics. Prerequisite: Chem. 344.
- 361. Advanced Organic Chemistry I. 4 hours.** A physical-organic approach to organic reactions with particular emphasis on reaction mechanisms and the relationship between reactivity and structure. Lectures and assigned reading. Prerequisites: Chem. 235 and 344.
- 362. Advanced Organic Chemistry II. 4 hours.** Continues Chem. 361. Lectures and assigned readings. Prerequisite: Chem. 361.
- 380. Principles of Physical Chemistry I. 3 hours.** Credit is not given for both Chem. 380-382 sequence and the 340-341-342 sequence. Chem. 380 and 382 provide an elementary introduction to physical chemistry with particular emphasis on topics of importance in the biological health sciences. Prerequisites: Chem. 119 or 121, calculus, and two quarters of physics; or consent of the instructor.
- 382. Principles of Physical Chemistry II. 3 hours.** Continues Chem. 380. Prerequisite: Chem. 380.
- 383. Elementary Physical Chemistry Laboratory. 1 hour.** An introductory laboratory course in physical chemistry. Prerequisite: Chem. 380.
- 399. Independent Study. 3 hours or more.** May be repeated for credit. Supervised study in an area not represented by regularly offered courses. Prerequisite: Written approval of the department.



## ENERGY ENGINEERING

### Professors

James P. Hartnett, Head of the Department; Paul M. Chung, Henry L. Garabedian, Norman A. Parker.

### Associate Professors

Chaim Gutfinger, David S. Hacker, John H. Kiefer, Wolodymyr J. Minkowycz, Harold A. Simon.

### Assistant Professors

Aemer D. Anderson, Joseph C. F. Chow, Edward S. Pierson, Calvin J. Wolf.

A program leading to the degree of Master of Science in Energy Engineering is offered by the department. The program is broadly based to accommodate students in aerospace engineering, mechanical engineering, chemical engineering, power engineering, and related fields. The areas upon which the above-mentioned fields are based are continuum and molecular fluid mechanics, heat and mass transfer, and macroscopic and microscopic thermodynamics.

This program may be used as a terminal program for those wishing to seek employment after graduation in one of the engineering fields mentioned above or as a basis for the continuation of studies toward the Ph.D.

### Admission Requirements

*Grade-Point Average:* 4.00 or better. Students with a 3.50 grade-point average may petition for consideration; those with less than a 3.50 average will not be admitted.

### Degree Requirements

Candidates must maintain a grade-point average of at least 4.00.

*Hours:* 48 quarter hours in 300 and 400-level courses, with no more than 24 hours at the 300 level, distributed as follows:

Courses in the major	27 quarter hours
Technical electives	12 quarter hours
Mathematics	9 quarter hours

Initially, an adviser is assigned to each student by the department. Subsequently, however, students are urged to select their own advisers in line with their field of concentration. The adviser may, at his discretion, require a thesis to document the student's research. If the thesis is written, 12 credit hours in Energy Engineering 499, Thesis and Research, will be given. It is recommended that students who will not do work beyond the Master's program write a thesis to gain experience in research.

### Courses for Graduate Students

**401. Classical Thermodynamics. 4 hours.** The postulatory approach to thermodynamics. Entropy maximum postulate. Conditions for equilibrium and stability. Property relations; reversibility; processes and cycles. Thermodynamics of elastic, magnetic, and electric systems. Prerequisite: Math. 220 or the equivalent.

- 402. Thermodynamics of Multicomponent Systems. 4 hours.** Application of the first, second, and third laws to chemical engineering systems. Concepts of chemical potential and fugacity. Availability and free energy. Chemical and phase equilibria with application to multicomponent and multiphase systems. Properties near the critical point. Law of corresponding states. Problems of a chemical engineering nature. Prerequisite: EnrE. 401 or the equivalent.
- 404. Irreversible Thermodynamics. 4 hours.** Irreversible systems approaching equilibrium. Method of irreversible thermodynamics; the Onsager's fundamental theorem; statistical and kinetic bases of the theorem. Engineering applications: chemical and electrochemical reactions; thermal diffusion thermophenomena; thermoelectric and thermomagnetic phenomena. Thermodynamic time. Prerequisite: EnrE. 401 or the equivalent.
- 406. Transport Phenomena. 4 hours.** Development of classical and statistical concepts of molecular diffusivity, conductivity, and other transport parameters. Kinetic theory of gases. Partition functions. Maxwell and Boltzmann distribution functions. Prerequisite: EnrE. 305 or the equivalent.
- 412. Potential Flow. 4 hours.** Fluid kinematics. Fundamental equations. Exact and approximate solutions of the potential equation. Conformal mapping. Airfoil theory. Surface waves. Prerequisite: EnrE. 212 or the equivalent.
- 414. Mechanics of Viscous Fluids. 4 hours.** Internal and external flows. Boundary layer analysis. Similarity solutions, integral methods, and other techniques for treating laminar and turbulent flows. Prerequisite: EnrE. 310 or the equivalent.
- 416. Compressible Fluid Mechanics. 4 hours.** Conservation equations. Equations of state. Surface of discontinuity. One-dimensional and two-dimensional subsonic and supersonic flows. Prandtl-Meyer expansions and shock phenomena. Theory of characteristics. Hodograph methods. Prerequisite: EnrE. 213 or the equivalent.
- 418. Fundamentals of Turbulence. 4 hours.** Mathematical descriptions of turbulence field; kinematics of homogeneous turbulence; correlation and spectrum tensors; dynamic behavior of isotropic turbulence; universal equilibrium theory; nonisotropic turbulence; transport processes in turbulent flows. Prerequisites: EnrE. 414 or 422 and Math. 323 or the equivalent.
- 421. Heat Conduction. 4 hours.** Analysis of heat conduction in solids, including the use of Fourier series, integral transforms, similarity transformations, and approximate methods. Prerequisite: Consent of the instructor.
- 422. Convective Heat Transfer. 4 hours.** Conservation equations. Momentum, heat, and mass transfer in laminar and turbulent boundary layers for internal and external flows. Convective heat transfer at high velocities. Heat transfer with change of phase. Special topics in convective heat transfer. Prerequisite: EnrE. 310 or the equivalent.
- 424. Thermal Radiation. 4 hours.** Introduction to Planck's quantum theory. Black body radiation. Wien's law. Stephen-Boltzmann's law. Basic concepts of total and spectral emissivity, absorptivity, reflectivity, and transmissivity. Kirchhoff's law. Radiation exchange between solid surfaces. Gaseous radiation. Radiation-convection interaction. Prerequisite: Consent of the instructor.
- 426. Radiation Gas Dynamics. 4 hours.** Basic laws and definitions of thermal radiation. Energy transfer in absorbing and emitting and scattering media. Thin and thick approximate methods. Radiative equilibrium. Combined conduction

and radiation. Combined convection and radiation. Prerequisites: EnrE. 414 or 422 and Math. 321 or the equivalent.

- 432. Kinetic Theory of Nonuniform Gases. 4 hours.** Kinetic theory distribution functions, Liouville theorem and Boltzmann equation. Moments of Boltzmann equation. Near-equilibrium perturbations; nonequilibrium analyses; rarefied gas flows; shock structure; nonequilibrium plasmas. Prerequisites: EnrE. 304, 310, and Math. 322 or the equivalent.
- 434. Plasma Dynamics. 4 hours.** Electromagnetic fields: motions of charged particles; statistical description of plasmas; ionization phenomena; Landau damping; electromagnetic waves; instabilities. Prerequisite: EnrE. 432.
- 436. Chemically Reacting Flows. 4 hours.** Nonequilibrium states; chemical thermodynamics and kinetics. Multicomponent continuum equations for flow of nonequilibrium fluids. Inviscid nonequilibrium flows. Boundary layer flows with surface and gas-phase reactions. Frozen and equilibrium criteria. Waves in relaxing media. Prerequisites: EnrE. 414 or 422 and 416.
- 451. Kinetics of Gas Reactions. 4 hours.** Basic concepts of reaction rate and mechanism. Collision theory, absolute rate theory, and theory of unimolecular decomposition. Dissociation, recombination, and chain reactions. Combustion, flames, and detonations. Catalysis. Prerequisites: EnrE. 304 or 305 or consent of the instructor.
- \*484. Mathematical Techniques of Nuclear Reactor Theory I. 4 hours.** Same as Math. 484. Introduction to nuclear physics and nuclear reactor physics; flux distribution, critical mass, slowing down kernels and their Fourier transforms, two-group steady state theory in the reflected reactor, buckling iteration method, matrix methods in boundary value and criticality problems in the one-dimensional multiregion reactor, series solutions of group diffusion equations in multiregion reactor and in two-dimensional fully reflected reactor, and in two-dimensional fully reflected reactor, reactor criticality codes. Prerequisites: Math. 312, 323, and 341 or 348; and 381 or equivalent; or consent of the instructor.
- \*485. Mathematical Techniques of Nuclear Reactor Theory II. 4 hours.** Same as Math. 485. Variational methods in the criticality problem, theory of control rods in cylindrical reactor, introduction to reactor kinetics, perturbation theory and applications, adjoint flux distribution, inhour equation for multiregion multifuel reactors, xenon poisoning and override problem. Prerequisite: EnrE. 484.
- \*486. Mathematical Techniques of Nuclear Reactor Theory III. 4 hours.** Same as Math. 486. Cylindrical reactor with source, power level determination problem, time-dependent flux distributions in multiregion reactor, one-group model, transient and stable flux distributions in multiregion reactor, two-group model, self-limiting power bursts, analysis of nonlinear feedback problems. Prerequisite: EnrE. 485.
- 491. Specialized Problems. 4 to 12 hours.** Specialized problems under the supervision of faculty. Prerequisite: Arrangement with the faculty.
- \*493. Current Topics of Energetics. 4 hours.** The particular topics will vary from quarter to quarter depending on the interests of the students and the specialties of the instructor teaching the course at the time. Prerequisites: Consent of the instructor.
- 499. Thesis Research. 0 to 16 hours.** Individual research in specialized problems under the supervision of faculty. Prerequisite: Arrangement with the faculty.

\*Approval pending.



## Courses for Graduate and Advanced Undergraduate Students

- \*304. Elementary Transport Phenomena. 4 hours.** Introductory kinetic theory of gases, transport properties, theory of real gases, simple kinetic theory of liquids. Prerequisites: EnrE. 201 and 211 and Math. 220 or the equivalent.
- 305. Statistical Thermodynamics. 4 hours.** Statistical formulation; partition functions, including quantum effect. Application to macroscopic systems; systems of interacting particles. Emphasis on engineering applications. Prerequisites: EnrE. 201 and Math. 220 or the equivalent.
- 307. Kinetic Theory of Gases and Transport Phenomena. 4 hours.** Basic concepts of kinetic theory of gases. Equations of state and their molecular interpretation. Elementary classical statistics, molecular collisions. Application of the kinetic theory to viscosity, heat conduction, and diffusion. Prerequisite: Completion of core program.
- 310. Continuum Fluid Mechanics. 4 hours.** Development of the conservation equations for a Newtonian fluid: continuity, Navier-Stokes, and energy equations. Some exact and approximate solutions of highly viscous, viscous, and inviscid flow problems. Prerequisite: Math. 220 or the equivalent.
- \*311. Free Surface Flows. 4 hours.** Application of the fundamentals of fluid mechanics to fluids with a free surface. Wave phenomena, channel flow, and free streamlines. Prerequisites: EnrE. 212 and 214.
- \*312. Porous Media. 4 hours.** Mechanics of fluid flow in porous media. Steady and unsteady flow in isotropic and anisotropic media. Multiphase and multilayered systems. Prerequisites: EnrE. 212 and 215.
- \*313. Aerodynamics of Flight. 4 hours.** Lift and drag, both subsonic and supersonic. Perturbation problems. Air foil and slender body theories. Three-dimensional wings. Prerequisites: EnrE. 212, 213, and 214.
- \*314. Propulsion. 4 hours.** Thermodynamics and fluid mechanics of air breathing engines. Performance of rockets: chemical, nuclear, and electrical. Prerequisites: EnrE. 202 and 213.
- \*321. Intermediate Heat Transfer. 4 hours.** Topics in conduction, convection, and radiation heat transfer, with special emphasis on the exact solutions of the problems. Two-phase flow; heat exchangers, mass transfer cooling; rarefied gas analysis. Prerequisite: EnrE. 221.
- 341. Experimental Methods and Techniques. 4 hours.** Purpose and design of experiments; statistical analysis of errors; wind tunnel, shock tube, high vacuum and chemical reactor techniques; theory of mechanical, thermal, optical and chemical measurements.
- \*351. Electromechanical Energy Conversion I. 4 hours.** Conversion of energy, electromagnetic forces, applications to linear and nonlinear lumped-parameter systems, stability. Principles of rotating machines and equations of motion. Applications to synchronous, induction, d-c, and novel machines. Prerequisites: InfE. 221 and credit or registration in InfE. 311, or consent of the instructor.
- \*352. Electromechanical Energy Conversion II. 4 hours.** Continues EnrE. 351, completion of rotating machines. Interaction of electromagnetic fields with stationary and moving continuous media, Maxwell stress tensor, and waves and instabilities. Applications to energy conversion with emphasis on fluids (magnetohydrodynamics). Prerequisites: EnrE. 351 and 211 and InfE. 320.

\*Approval pending.

- \*353. Direct Energy Conversion. 4 hours.** Study of novel methods of converting heat into electrical energy. Consideration of magnetohydrodynamics, thermionics, and fuel cells. Prerequisites: EnrE. 257 and 352 or consent of the instructor.
- \*356. Introduction to Plasmas. 4 hours.** Motion of particles in electric and magnetic fields, kinetic theory and elementary processes. Boltzmann equation, macroscopic equations, transport coefficients. Creation of ionized gas. The magnetohydrodynamic approximation. Waves and instabilities. Prerequisites: InfE. 221 or the equivalent.
- \*391. Seminar. 1 to 4 hours.** Topics to be arranged. Prerequisites: Senior standing and consent of the instructor.

## ENGLISH

### Professors

Robert B. Ogle, Head of the Department; Josephine W. Bennett (Visiting), Arna Bontemps, Dean B. Doner, Alexander Karanikas, Clara Kirk (Visiting), Rudolf Kirk (Visiting), Bernard R. Kogan, Louis Marder, Ralph J. Mills, Jr., John F. Nims, Harry J. Runyan, Jaroslav Schejbal (Visiting), Andrew Schiller, James B. Stronks, Samuel A. Weiss, Martin L. Wine, Elizabeth Wright.

### Associate Professors

Guinevere Griest, John B. Shipley, Maurita Willett.

### Assistant Professors

William E. Doherty, Beverly Fields, Robert Gladish, Adam Makkai, Valerie B. Makkai, Patricia McFate, Ted-Larry Pebworth, A. LaVonne Ruoff, Mary Thale, Robert Vales.

The department offers courses of study leading to the degree of Master of Arts in English, with specialization in English literature, American literature, and linguistics.

### Admission Requirements

Applicants must present the equivalent of 30 quarter hours of study in English and American literature, with no fewer than 8 hours in either, except that specialization in linguistics requires no specific background in English study (see below, under *Linguistics*). Students with less than the minimum 30 quarter hours may petition for special consideration from the department. All applicants must have a grade-point average of 4.00 (A=5.00) for the last 90 quarter hours (or the last 60 semester hours) of undergraduate study. Special consideration, however, may be given petitions of students with fewer than 30 quarter hours or with a grade-point average between 3.75 and 4.00. Applicants will be expected to show satisfactory scores on the Graduate Record Examination, Advanced Test in Literature.

### Degree Requirements

**Hours:** The candidate specializing in English must present 48 quarter hours of course work, including English 400, Introduction to Bibliography and Research, and four additional 400-level courses. Of the 48, at least 36 must be in

\*Approval pending.

English; the remaining must be either in English or in approved courses in other departments.

*Thesis:* Optional; the student may write either a thesis or three seminar papers. Those electing to write a thesis will be held responsible for nine courses, including English 400 and three other 400-level courses, exclusive of English 499. Students electing the nonthesis option will prepare twelve courses, at least nine of which must be in English, including English 400 and four other 400-level courses. Three seminar papers at the 400 level must be reviewed and approved by the Graduate Committee.

Applicants for the degree must demonstrate reading proficiency in French or German. Classical languages may be substituted, and another modern foreign language may be authorized by the Graduate Committee of the department.

All candidates are required to pass a comprehensive examination.

## Linguistics

The department offers two programs in linguistics:

*The terminal Master's program* in linguistics is intended primarily for teachers of English and other languages. The students who get the terminal M.A. will not, presumably, go on to a doctorate and become professional linguists. Their course work, consequently, is intended to give them a good general background in linguistics. Furthermore, since these are teachers, the emphasis is to some extent literary.

*The predoctoral Master's program* in linguistics aims to establish a firm groundwork for persons who intend to go on to become professional linguists. Consequently, the emphasis is not literary or pedagogical, but scientific.

## Courses for Graduate Students

- 400. Introduction to Bibliography and Research. 4 hours.** Detailed study of bibliographic tools and examination of various kinds of research papers. Required of graduate students in English.
- 401. Studies in Old English I. 4 hours.** Grammatical analysis of the major dialects; representative readings in each. Prerequisite: Engl. 314 or the equivalent.
- 403. Chaucer. 4 hours.** Critical study of *Canterbury Tales*.
- 404. Chaucer. 4 hours.** Critical study of Chaucer's works, except *Canterbury Tales*; special emphasis on *Troilus and Criseyde*.
- 405. Problems in Shakespeare Scholarship. 4 hours.** Biographical, bibliographical, and critical problems of Shakespearean scholarship and criticism as they relate to Shakespeare the man and to the study of the plays and poems. Prerequisite: At least one undergraduate course in Shakespeare above the 100-level.
- 419. Milton. 4 hours.** Studies in prose and poetry.
- 420. Studies in the Novel before Fielding. 4 hours.** Background survey of Renaissance fiction, including foreign, Spanish picaresque, French romance, nouvelle, and the like; investigation of fictional forms such as rogue literature and letter books in the seventeenth century; study of individual authors, for example, Bunyan, Aphra Behn, and Defoe.



421. **The Late Eighteenth Century Novel. 4 hours.** Representative works of the following kinds of fiction: post-Richardson novels of sentiment and sensibility, the philosophical tale and novels of instruction, the tale of terror, the novel of manners, and the novel of doctrine and social theory.
425. **Studies in Romanticism. 4 hours.** Close examination either of a single important feature of the Romantic movement or of the chief works of one or two of the major Romantics. The content may vary from quarter to quarter; but the course will deal with important works by one or two major figures or with a subject, theme or genre; or with a significant influence upon English Romanticism.
435. **Victorian Nonfiction Prose. 4 hours.** Intensive study of social, political, and literary essays of the period.
439. **The American Novel since the Second World War. 4 hours.** Seminar on selected American novels, emphasizing new trends in the novel.
440. **Studies in Modern British Poetry. 4 hours.** Major poets such as Yeats, Auden, and Thomas; also traditional figures such as Graves and Muir; and larger questions of tradition and innovation, poetry and politics, and the successive "movements" in modern English verse.
441. **Studies in Modern British Drama. 4 hours.** Trends, authors, and forces shaping modern British drama and theater.
445. **Studies in the Nineteenth Century American Novel. 4 hours.** Close reading of selected texts of novelists from Charles Brockden Brown to Stephen Crane.
446. **Studies in the Imagist Poets and Their Followers. 4 hours.** Poetry and theory of Ezra Pound, Richard Aldington, Hilda Doolittle, Amy Lowell, and others from 1912 to 1917. Imagist aspects of recent major poets.
447. **Studies in Negro Authors I: Langston Hughes and His Circle. 4 hours.** Assessment of the poetic impulse as revealed in the writings of Hughes and his contemporary Negro poets. A search for the roots of their self-expression.
448. **Studies in Negro Authors II: Richard Wright and Selected Contemporaries. 4 hours.** Search for common roots of experience realized in the writings (mainly fiction) of Wright, Jean Toomer, Ralph Ellison, Lorraine Hansberry, and others of their period.
449. **Studies in Negro Authors III: The Frame of Reference. 4 hours.** The role of the essayists. The writings of W. E. B. Du Bois, James Weldon Johnson, Alain Locke, William Stanley Braithwaite, Saunders Redding, and others, leading to the contemporary group.
450. **Studies in American Thought and Culture. 4 hours.** Selected topics.
451. **Phonetics and Phonemics. 4 hours.** Principles of phonetics, articulatory, auditory, and acoustic. Phonemic analysis of English and other languages. Practice in transcription.
452. **Applied English Linguistics I. 4 hours.** Applications of linguistic science to the teaching of English syntax and grammar. Prerequisite: Engl. 387.
453. **Applied English Linguistics II. 4 hours.** Applications of linguistic science to problems of style, rhetoric, and metrics. Emphasis on the literary implications of linguistic knowledge. Prerequisite: Engl. 387.

- 454. **Linguistics and Language Learning. 4 hours.** Applications of linguistic science to the teaching of foreign languages. Development of comparative descriptions.
- 461. **Linguistic Analysis. 4 hours.** The bases of grammatical analysis, including phonology, syntax, and morphophonemics. Prerequisite: Engl. 387.
- 463. **Dialectology. 4 hours.** Description and mapping of dialects, both synchronically and diachronically. Methods of dialect geography. Prerequisite: Engl. 451.
- 497. **Research in English. 4 hours.** Students will be assigned to this course at the discretion of the English department. May be repeated for a maximum of 16 hours. Independent research in English and American literature and linguistics.
- 499. **Thesis Research. 0 to 16 hours.** Students will be assigned to this course at the discretion of the English department. May be repeated for a maximum of 16 hours. For students involved in thesis research and writing for advanced degrees.

### **Courses for Graduate and Advanced Undergraduate Students**

- \*301. **Introduction to the English Language. 4 hours.** English as a language. Making use of the basic concepts of general descriptive and comparative linguistics, English is examined in its relationship to other languages, its history, and its present structure.
- 302. **Tennyson and Browning. 4 hours.** A close study of the lyric poetry and the dramatic monologues of Tennyson and Browning; brief examination of Tennyson's Arthurian idylls and of the plays of both.
- 303. **Carlyle and Mill. 4 hours.** Major works.
- 305. **Newman and Arnold. 4 hours.** The prose of one early and one mid-Victorian writer: their contributions to nineteenth century religious and educational theories. Arnold's literary and social criticism; the rhetoric of both. Brief reference to the poems and letters of each that most closely parallel ideas and moods in their prose.
- 306. **Dickens and Thackeray. 4 hours.** A close study of the major writings of the two representative Victorian novelists.
- 307. **Yeats and Eliot. 4 hours.** A detailed study of the two most influential poets in English of the twentieth century. Study of specific texts; some emphasis on the intellectual and spiritual attitudes represented by each.
- \*310. **American Puritanism. 4 hours.** An intensive study of the Puritans in America and their writings. The readings range from William Bradford to Jonathan Edwards and touch upon the major aspects of Puritan life and thought.
- 311. **Chaucer. 4 hours.** Readings in the major works.
- 312. **Introduction to Old English. 4 hours.** The elements of Old English grammar and the reading of graded prose selections.
- 313. **Old English Poetry and Prose. 4 hours.** Heroic, elegiac and religious poetry of England to 1200, exclusive of *Beowulf*; representative prose. Prerequisite: Engl. 312.
- 314. **Beowulf. 4 hours.** A detailed explication of the poem. Prerequisite: Engl. 313.

\*Approval pending.

- 315. Introduction to Descriptive Linguistics. 4 hours.** Introduction to theories of the syntactic, morphological, and phonological analysis and the description of language.
- 316. American Drama. 4 hours.** The major dramatic writings in American literature.
- 317. The Writing of Poetry. 4 hours.** Limited to 15 students. May be repeated for a maximum of 12 hours. The practice of the writing of poetry, aided by intensive study of examples. Prerequisite: 12 hours of English literature and consent of the instructor.
- \*320. Middle English Literature. 4 hours.** Prose and poetry of the later middle ages: major poems such as *Gawain and the Green Knight*, *The Pearl*, *Piers Plowman*; lyrics; religious and secular prose.
- \*321. Medieval Literature I. 4 hours.** Selected works in Middle English and continental medieval writings in English translation.
- \*322. Medieval Literature II. 4 hours.** Continues English 321.
- \*323. Wordsworth and Coleridge. 4 hours.** A close examination of the major works, both poetry and prose.
- 324. Byron, Shelley, and Keats. 4 hours.** A study of the major figures of the second generation of Romantics.
- 331. The Important Minor Plays and the Poems of Shakespeare. 4 hours.** A study of the important minor plays and of the poems and sonnets. Prerequisite: Engl. 231 or 232 or consent of the instructor.
- \*332. The Poetry of Edmund Spenser. 4 hours.** An introduction to *The Faerie Queen* and *The Shepheardes Calendar*, with some attention to the minor verse and its place in the English Renaissance.
- 334. Literary Criticism, Theory, and Practice. 4 hours.** Survey of literary criticism, focusing on major critics from Plato to Arnold.
- 335. Modern Literary Criticism. 4 hours.** Survey of modern literary criticism from Matthew Arnold to the present. Prerequisites: Engl. 334 or consent of the instructor.
- 336. Renaissance Drama Exclusive of Shakespeare. 4 hours.** Major dramatic works of Shakespeare's contemporaries.
- 337. Exercises in Literary Criticism: Poetry. 4 hours.** Advanced course in practical criticism of poetry in English. Prerequisite: Engl. 334 and 335 or the equivalent, or consent of the instructor.
- 338. Tragedy. 4 hours.** A formal and theoretic inquiry into tragedy: its origins, evolution, and significance, based on selected masterworks of various periods.
- 339. Comedy. 4 hours.** The history and theory of comic drama.
- 341. Dryden. 4 hours.** Dryden's poems, plays, and literary criticism; emphasis on the interaction of these genres in Dryden's development. Individual conferences on assigned papers are required.
- \*342. The Poetry of Milton. 4 hours.** Origins, forms, artistic and ethical values; Milton's place in English literary history.



- 345. The Metaphysical Poets. 4 hours.** Donne to Crashaw. Class reading and discussion of the poetry of Donne, Herbert, Vaughan, Crashaw. Special emphasis on the poetry of Donne.
- 347. Restoration Drama. 4 hours.** Major dramatic works after the reopening of the public theaters in 1660; development from aristocratic Baroque tragedy and comedy to the beginnings of bourgeois sentimental drama. Dryden, Etherege, Wycherley, Congreve, Vanbrugh, Farquhar, Otway, Cibber, and others.
- \*348. Swift. 4 hours.** A detailed study of the works of Jonathan Swift in light of the intellectual and aesthetic currents of the period.
- \*349. Johnson and Boswell. 4 hours.** The principal writings of Dr. Johnson and of Boswell.
- 350. The American Transcendentalists. 4 hours.** The Transcendentalist circle in and about Concord from 1830 to 1860: Emerson and Thoreau, Alcott, Brownson, Fuller, Ripley, Parker, Channing, and others. Prerequisite: Engl. 255 or Hist. 356 or 357.
- \*351. English Prose of the Eighteenth Century. 4 hours.** A survey of eighteenth century prose, with emphasis on the development of prose styles and their relations to modes of thought in the century.
- \*352. Pope. 4 hours.** A detailed study of the works of Alexander Pope in the light of the intellectual and aesthetic currents of the period.
- \*355. American Fiction from 1800 to 1860. 4 hours.** An intensive study of the background and development of traditions and themes in American fiction from 1800 to 1860.
- 357. Studies in the Short Story. 4 hours.** The short story as a literary form, with close readings of selected short stories.
- \*364. Readings in the Lyric I: European. 4 hours.** Selections from the work of Sappho, Catullus, Petrarch, Villon, San Juan de la Cruz, Goethe, Leopardi, Baudelaire. Students are expected to have a reading knowledge of at least one of the foreign languages involved.
- \*365. Readings in the Lyric II: English. 4 hours.** Selected lyrics from the thirteenth through the nineteenth century.
- \*366. Readings in the Lyric III: Twentieth Century. 4 hours.** Selections from the work of Yeats, Valery, Rilke, Frost, Montale, Garcia Lorca, Auden. Students are expected to have a reading knowledge of at least one of the foreign languages involved.
- \*375. Henry James and the Technique of Fiction. 4 hours.** A study of the development of Henry James as a novelist.
- 376. W. D. Howells: Realism in Fiction and Criticism. 4 hours.** The career of William Dean Howells as a journalist, novelist, editor, and critic; his influence on the development of realism in late nineteenth and early twentieth century American literature.
- 377. Naturalism in the American Novel: Dreiser, Crane, Norris, Lewis, and Others. 4 hours.** The development of the naturalistic novel; special emphasis on Dreiser and his followers.

380. **The Rise of Realism. 4 hours.** The rise of realism in American fiction from 1850 to 1900; Old Southwest humor, local color, Twain, Howells, Crane, the early naturalists, and others. Prerequisite: Engl. 256.
382. **The Plays of Bernard Shaw. 4 hours.** A critical, social, and philosophical inquiry.
385. **Faulkner and Hemingway. 4 hours.** Studies in the short stories and novels of the two writers; examination of their literary theories.
386. **Hawthorne and Melville. 4 hours.** Two major writers of the nineteenth century; detailed analysis of one major novel of each. Prerequisite: Engl. 255 or consent of the instructor.
387. **The Structure of English. 4 hours.** Traditional and structuralist grammatical descriptions; introduction to transformational grammatical studies; detailed survey of a transformational syntax of English; brief introduction to generative phonology and morphophonemic analysis of English, especially stress. Prerequisite: Engl. 301.
388. **Southern Fiction. 4 hours.** Major works.
389. **Walt Whitman and Emily Dickinson. 4 hours.** The poetry and major prose of Whitman; the poems of Emily Dickinson. Prerequisite: Consent of the instructor or an A or a B in any one of the following: Engl. 256, 289, 302, 307, 323, 324, or 345 or 366.
392. **The Negro in American Literature: Poetry. 4 hours.** Historical and analytical study of the Negro contribution to American poetry.
393. **The Negro in American Literature: Prose Fiction. 4 hours.** Historical and analytical study of the Negro contribution to American prose fiction.
394. **Studies in American Negro Literature. 4 hours.** Detailed study of aspects of writing by American Negroes.

## **GEOLOGY**

### **Professors**

Werner H. Baur, Head of the Department; Robert W. Karpinski.

### **Associate Professors**

Robert E. DeMar, Wilfred A. Elders, Richard B. McCammon.

### **Assistant Professors**

Kelvin S. Rodolfo.

Work leading to the degree of Master of Science is offered in these areas: crystallography, mineralogy, petrology, and geochemistry; paleontology, oceanography, sedimentology, and sedimentary geochemistry.

## **Admission Requirements**

Admission generally requires a minimum grade-point average of 4.00. However, the department will rely strongly on recommendations from the applicant's undergraduate professors and on the grade-point average attained in the

last two years of college. Geology students with a strong background in mathematics, physics, chemistry, and biology will receive preferred consideration, although students who have degrees in other sciences will be admitted. Serious deficiencies in undergraduate training in geology or other sciences will have to be corrected during the graduate program. The program will be selected by the student and his adviser(s) to correspond with his area of specialization.

## Degree Requirements

*Hours:* 48 quarter hours, 24 of which must be in the area of concentration. The area of concentration may, as in the case of evolutionary paleontology, span several academic disciplines. A minimum of 16 quarter hours must be taken in 400-level courses; 8 of these should be in the area of concentration.

*Thesis:* The student must complete a written report or a thesis involving eight quarter hours of work on an independent study or research project selected with the approval of his faculty supervisor. The department may request the student to complete a comprehensive examination in his area of specialization and independent study. The independent study report or thesis will be evaluated by a departmental committee including one member selected from outside the faculty of the Chicago Circle campus.

Candidates must demonstrate competence in reading the scientific literature of at least one foreign language. French, German, and Russian are the preferred languages.

## Courses for Graduate Students

- 420. **Advanced Vertebrate Paleontology. 4 hours.** Same as BioS. 420. Given as three different courses. May be repeated twice for credit. Advanced treatment of the functional morphology, paleoecology, and phylogeny of the various vertebrate groups: fishes, amphibians and reptiles, and mammals. Prerequisites: Geol. 318 and BioS. 282.
- 430. **Advanced Mineralogy. 4 hours.** May be repeated if the same topic is not covered twice. Various topics in one of the following categories: structural mineralogy, x-ray crystallography, optical properties of minerals, and crystal chemistry and mineral synthesis. Lectures, seminars, and laboratory. Prerequisites: Geol. 205, 206, and consent of the instructor.
- 432. **Advanced Geochemistry. 4 hours.** May be repeated if the same category is not covered twice. Advanced topics in one of the following categories: isotope geochemistry and geochronology, distribution of elements in the earth's crust, mineral systems with and without volatile components, and low-temperature mineral systems. Lectures, seminars, and laboratory. Prerequisites: Geol. 335 and consent of the instructor.
- 460. **Marine Geology. 4 hours.** Origin and nature of marine sediments, tectonics and geomorphology of the ocean floor, including methods of mapping and measuring submarine topography. Prerequisites: Geol. 220 and 340.
- 495. **Advanced Studies in Geology. 2 to 8 hours.** May be repeated twice. Independent study or research under a faculty supervisor culminating in a written report. Work may be taken in the following fields: stratigraphy, sedimentation,



paleontology and paleoecology, vertebrate paleontology, mineralogy and petrology, crystallography, geochemistry, engineering geology, oceanography. Prerequisites: Consent of the head of the department and the faculty member who will act as study supervisor.

499. **Thesis Research. 0 to 16 hours.** Individual work under the supervision of faculty members in their respective fields. Prerequisites: Consent of the thesis supervisor and the head of the department.

## **Courses for Graduate and Advanced Undergraduate Students**

316. **Invertebrate Paleontology. 4 hours.** Same as BioS. 316. Phylogeny, morphology, and ecology of the fossil invertebrates. Prerequisites: Geol. 218 and consent of the instructor.
318. **Vertebrate Paleontology. 4 hours.** Phylogeny, morphology, and ecology of the fossil vertebrates.
319. **Paleobotany. 4 hours.** Same as BioS. 319. Structure, phylogeny, and stratigraphic distribution of representative fossil plants. Lecture, laboratory, and field trips. Prerequisite: One year of biological sciences.
335. **Geochemistry. 4 hours.** Principles of the distribution of the elements in the earth's crust. Element partitioning between coexisting minerals. Origin of the elements. Introduction to thermodynamic considerations of mineral equilibria. Prerequisite: Chem. 112, 113, and 114, or consent of the instructor.
340. **Introduction to Oceanography. 4 hours.** A physical description of the marine environment; the physical and chemical properties of sea water; currents, wave action, tidal forces, geography and geology of the ocean basins. Relation of the marine organism to the physical environment. Prerequisite: Consent of the instructor.
345. **Advanced Crystallography. 4 hours.** Crystalline properties of minerals. Theory and practice of determining the crystalline structure of minerals. Prerequisite: Geol. 205 or consent of the instructor.
360. **Introductory Geophysics. 4 hours.** The shape and figure of the earth, gravity, seismology, and magnetism. Thermodynamics of the earth; atmospheric and planetary geophysics. Prerequisite: Consent of the instructor.

## **GERMAN**

### **Professors**

Robert R. Heitner, Head of the Department; Lee B. Jennings, Robert Kauf, Daniel C. McCluney, Jr., Hazel Vardaman, Leroy R. Shaw, Elizabeth Teichmann.

### **Associate Professors**

Arnold J. Hartoch, Bruno F. O. Hildebrandt, Ernest S. Willner.

### **Assistant Professors**

Else Hünert-Hoffman, Karl F. Otto, Jr.

Work leading to the degree of Master of Arts is offered in two areas of specialization: German literature; German philology and linguistics.

## Admission Requirements

Applicants must have a bachelor's degree with a major in German from an accredited institution or the equivalent from a foreign university. Those whose undergraduate preparation in German is deemed inadequate may be admitted at the discretion of the department but will be required to take supplementary course work on the undergraduate level. Applicants are expected to have a grade-point average of 4.00 in their undergraduate work in German; those with averages between 3.50 and 4.00 may be considered on an individual basis.

Entering students must have the ability to read literary and critical German with speed and accuracy and to follow class lectures presented in German. They should also have an elementary acquaintance with German linguistics and some knowledge of the main outlines of German literature from 1750 to the present.

## Degree Requirements

The candidate must take a minimum of 48 quarter hours of course work, including at least 36 hours in the major field (18 of these must be in 400-level courses), and at least one graduate seminar in German. He must also prepare an acceptable thesis or departmental Master's paper and must pass a final comprehensive examination on his:

Ability to write and speak German.

Knowledge of the linguistics, grammar, history, and structure of the German language.

Knowledge of the main outlines of German literature and culture.

Competence in a concentrated field of specialization in German linguistics or literature.

## Courses for Graduate Students

401. **Practical Stylistics and Analytical Grammar I. 3 hours.** Prerequisite: Ger. 204 or the equivalent.
402. **Practical Stylistics and Analytical Grammar II. 3 hours.** Prerequisite: Ger. 401 or the equivalent.
403. **Germanic Linguistics. 4 hours.** Linguistic geography, "Sprachschichten," and principles of structural linguistics. Prerequisite: Adequate knowledge of German. Primarily for students in German but open to qualified students in other fields.
405. **History of the German Language. 4 hours.** Structural and lexical development.
408. **Bibliography and Research Methods. 4 hours.**
410. **Middle High German. 4 hours.**
425. **Goethe and Schiller — The Weimar Period. 4 hours.**
426. **Romanticism. 4 hours.** Literature, theories, and philosophy of eighteenth and nineteenth century German Romanticism.

- 427. **Poetic Realism. 4 hours.** German literature between Romanticism and Naturalism.
- 428. **Modern German Literature from 1890 to 1930. 4 hours.**
- 440. **Seminar in Literature for M.A. Candidates. 4 hours.** May be repeated for credit. Topics will vary. Prerequisite: Consent of the instructor.
- 441. **Seminar in Linguistics for M.A. Candidates. 4 hours.** May be repeated for credit. Topics will vary. Prerequisite: Consent of the instructor.
- 490. **Independent Study for Graduate Students. 1 to 16 hours.** Prerequisite: Consent of the instructor.
- 499. **Thesis Research. 0 to 16 hours.** Prerequisite: Approval of the department.

### **Courses for Graduate and Advanced Undergraduate Students**

- 370. **The German Novelle. 4 hours.** Reading and interpretation of representative *Novellen* of the nineteenth and twentieth centuries. Prerequisites: Ger. 221 and two additional German literature courses or consent of the instructor.
- 372. **German Drama. 4 hours.** Development of the German drama from the Enlightenment to the present. Prerequisites: Ger. 221 and two additional German literature courses or consent of the instructor.
- 374. **Poetry from the Seventeenth Century to the Present. 4 hours.** Prerequisites: Ger. 221 and two additional German literature courses or consent of the instructor.
- 380. **Goethe's Faust. 4 hours.** Intensive study of Parts I and II. Prerequisites: Ger. 221 and two additional German literature courses or consent of the instructor.
- 382. **German Literature to 1750. 4 hours.** Prerequisites: Ger. 221 and two additional German literature courses or consent of the instructor.
- 390. **Topics in German Literature. 4 hours.** May be taken more than once for credit. Reading and discussion of the work of one prominent German author or of a group of related authors. Subject varies and is chosen by the instructor. Prerequisites: Ger. 221, 290, 292, and 294 or consent of the instructor.

## **HISTORY**

### **Professors**

Robert V. Remini, Chairman of the Department; Shirley A. Bill, Louis Gottschalk (Visiting), Peter d'A. Jones, Stanley L. Jones, Robert L. Nicholson, Gilbert Osofsky, Edward C. Thaden, John B. Wolf.

### **Associate Professors**

Peter J. Coleman, Carolyn A. Edie, Margaret Y. George, Bentley Gilbert, Robert L. Hess, Richard Millman.

### **Assistant Professors**

Robert E. Conrad, Mary E. Conroy, Robert A. Friedlander, Melvin G. Holli, George Huppert, David Jordan, Ronald P. Legon, Kenneth A. Lockridge, Peter R. McKeon, Karl A. Schleunes.



The Department of History offers work leading to the Master of Arts and Doctor of Philosophy degrees.

## Admission Requirements

Applicants must have a grade-point average of at least 4.00 for the last 90 quarter hours of undergraduate study. Students with averages below 4.00 but above 3.75 are considered on an individual basis. Three letters of recommendation from former professors are required of all applicants. Students are urged to take the Graduate Record Examination, although it is not a requirement.

*Hours:* A student must present a Bachelor of Arts degree with a major in history or with a minimum of 24 quarter hours in history or he may petition the department for admission. Only in the most exceptional cases will part-time students be admitted as Master of Arts candidates. (Full time is defined as 12 or more quarter hours.) The department may require a candidate to repair any deficiencies in his preparation before granting him full standing in the graduate program. A minimum of two years of undergraduate training in a foreign language is required.

## Degree Requirements

*Master of Arts.* The candidate must pass a comprehensive examination in one major field and two minor fields selected from among the following fields of specialization: ancient world, medieval Europe, early modern Europe, modern Europe, Russia, Great Britain, America (United States), Africa, imperialism and colonialism, and historiography. Candidates are expected to take at least 12 hours in each of two of these fields of specialization. A minimum of 48 quarter hours is required for the degree, 16 of which must be at the 400 level. Of these 16, 12 must be in history courses. A student who has done graduate work in a recognized institution without receiving a degree may petition to receive credit by examination. No thesis is required. The candidate must pass a reading examination in a foreign language relevant to his program of study. The language presented to meet this requirement must be approved by the department. For work in certain fields, a reading knowledge of the particular language or languages relevant to that field may be required.\* A student may take a minor in another discipline with the approval of the department.

The candidate must maintain an average of at least 4.00. No credit toward the degree will be given for any course in which the student receives a grade of less than B.

*Doctor of Philosophy.* The department offers work leading to the doctorate in the fields of European and American history.

The doctorate in history represents mastery of several general areas of historical knowledge and calls for an original contribution to scholarship through independent study and research. Ordinarily, the candidate will complete a minimum of 48 quarter hours of graduate courses and seminars beyond the Master's degree. Unless the candidate holds a Master of Arts degree from the University

\*Students planning to transfer to another school to continue graduate work beyond the M.A. are advised to check the foreign language requirement at that school.

of Illinois at Chicago Circle or from an accredited institution and has been recommended for further advanced study, he will be expected to take a qualifying examination for the M.A. The candidate for the degree must also stand for oral and written preliminary examinations. Lastly, he must present an acceptable dissertation and defend it in a final oral examination.

All Ph. D. candidates must have a reading knowledge of two foreign languages. In many fields of history command of a foreign language is indispensable for advanced study and research, and it is expected that that language will be used in course and seminar work as required. In some fields it is recognized that other tools, such as statistical theory, may be equally indispensable.

The program of study for each candidate will be fixed by the candidate and his adviser with the approval of the graduate advisory committee of the Department of History.

Candidates must offer one major field of preparation and three minor fields, one of which may be outside the department, for the preliminary examinations. Two of the minor fields must be either geographically or chronologically outside the areas of his major field. The major fields of study offered by the department are: European history from 1450 to 1815; European history since 1648; American history from 1500 to 1877; American history since 1765; Russian history; British history since 1688. Minor fields in European history are the Age of the Enlightenment, diplomatic history since 1648, Bourbon France, revolutionary and Napoleonic France, Italy since 1789, intellectual history since 1815, Great Britain since 1837, imperialism and colonialism, historiography; in American history, economic history, Negro history, political parties, urban history, early national period, the Jacksonian Era, the Civil War and Reconstruction, the progressive era, and the contemporary United States. Fields other than those listed may be accepted in individual cases. The work that a candidate may offer in other departments shall be determined in consultation with his adviser.

*Urban Studies and Negro History.* Graduate students will have an opportunity to pursue research in American urban studies and Negro history in the University's Urban History Manuscript Collection, a rich repository of materials dealing with the social, economic, and political history of the United States and particularly with the history of the metropolitan Chicago area. Through the materials in this collection, students in history will be trained in the use of manuscripts as well as other primary materials employed in the study and writing of history.

## Courses for Graduate Students

**Note:** Seminars are generally offered in two-quarter or three-quarter sequences. Several seminar sections are offered in European, American, and British research topics each year. Students may enroll in more than one section.

**413. Seminar in Ancient History. 4 hours.**

**417. Seminar in Medieval History. 4 hours.**

**418. Seminar in Renaissance History. 4 hours.**

- 421. Seminar in European History. 4 hours.
- 428. Seminar in African History. 4 hours.
- 429. Seminar in Russian History. 4 hours.
- 433. Seminar in British History. 4 hours.
- 451. Seminar in American History. 4 hours.
- 469. Seminar: Theoretical, Historical, and Philosophical Issues in Psychology. 2 hours. Same as Phil. 479 and Psch. 479. May be repeated. Systematic review of special topics, with emphasis on current approaches and interpretations. Prerequisite: Consent of the instructor.
- 479. Seminar in Urban History. 4 hours.
- 491. Historical Methods. 4 hours. A laboratory course to provide understanding of the study of history and practical application of the methods by which the past is reconstructed.
- 492. Historiography. 4 hours. The great historians from early times to the present.
- 497. Research and Writing. 0 to 12 hours. Special problems in research and individual guidance in the preparation of master's research essays.
- 498. Independent Study. 0 to 12 hours.
- 499. Thesis Research. 0 to 16 hours.

### **Courses for Graduate and Advanced Undergraduate Students**

**Note:** Graduate students must have background or training appropriate to the course content of any 300-level course.

- 301. Church and State in Medieval Europe, the Eleventh Through the Twelfth Centuries. 4 hours. The development of papal centralization from 1049 to 1123, beginning with an examination of the church under feudal domination, the reforms of the Saxon and Salian emperors, and the origins of papal independence are investigated. The basic opposition between imperial and papal assertions of hegemony and the dispute over lay investiture as an aspect of the controversy are the focal points for study of the ecclesiology of Gregory VII and his successor. Individual conferences on assigned papers are required.
- 302. Byzantine Civilization from 330 to 1054. 4 hours. The cultural, religious, and social history of the Eastern Roman Empire from the founding of Constantinople to 1054. Special attention to the continuation of classic ideals and Byzantine relations with the Latin West and the Slavic, especially Russian, worlds. Individual conferences on assigned papers are required.
- 303. History of Byzantine Civilization from 1054 to 1453. 4 hours. The cultural, religious, and social history of the Eastern Roman Empire from 1054 to the fall of Byzantium in 1453. Special attention to the continuation of classic ideals and Byzantine relations with the Latin West and the Slavic, especially the Russian, worlds. Individual conferences on assigned papers are required.
- 304. Intellectual History of the Medieval Western World. 4 hours. Intellectual and religious thought and learning from the Age of the Fathers to Dante and William of Occam. Some attention is given to cross-cultural relations with the Byzantine and Islamic East. Individual conferences on assigned papers are required.



305. **The Middle Ages from 400 to 814. 4 hours.** Europe from the time of the barbarian invasions to the death of Charlemagne. Individual conferences on assigned papers are required.
306. **The Middle Ages from 814 to 1250. 4 hours.** Europe from the death of Charlemagne to the death of Frederick II. Individual conferences on assigned papers are required.
307. **The Middle Ages from 1250 to 1500. 4 hours.** Europe from the rise of the towns to the establishment of national monarchy. Individual conferences on assigned papers are required.
308. **The Renaissance. 4 hours.** Major intellectual, cultural, political, social, and economic developments and issues of Renaissance Europe. Individual conferences on assigned papers are required. Prerequisite: One course in history or consent of the instructor.
309. **History of Russian Foreign Policy to 1917. 4 hours.** Russian foreign policy from the reign of Peter I to the Revolution. Prerequisite: Consent of the instructor.
311. **The Age of the Reformation. 4 hours.** The Protestant and Catholic reformations of the sixteenth century. Individual conferences on assigned papers are required. Prerequisite: One year of European history.
312. **The Age of Philip II. 4 hours.** Europe during the second half of the sixteenth century, the age of Spanish Imperialism; religious war and economic expansion. Individual conferences on assigned papers are required.
313. **Sixteenth Century Civilization in Europe. 4 hours.** European culture from the generation of Copernicus to the generation of Galileo. The origins of modern thought and ideology studied in the context of sixteenth century society. Individual conferences on assigned papers are required.
314. **Europe in the Seventeenth Century. 4 hours.** Major political, religious, economic, social, and cultural developments and issues of seventeenth century Europe. The growth of the French monarchy, the Hapsburg Empire, the Thirty Years' War, the English constitutional crises, international problems and politics, political theory, the scientific revolution, and economic and social problems. Individual conferences on assigned papers are required.
315. **Europe in the Eighteenth Century. 4 hours.** Major features of the structure and operations of international relations, diplomacy, and warfare in the eighteenth century; economic and political systems of the major states of Western Europe from 1715 to 1789. Individual conferences on assigned papers are required.
316. **Europe from 1789 to 1848: Revolution and Reaction. 4 hours.** The French Revolution; Napoleon and the emergence of a new Europe with the forces of liberalism, nationalism, Romanticism, and conservatism; the meeting of these forces in the revolutions of 1848. Individual conferences on assigned papers are required.
317. **Europe from 1848 to 1914: Unification, Power, and Conflict. 4 hours.** The unification of Germany and Italy, the rise of industrialism and the new imperialism, the advent of *Realpolitik* and the background of World War I. Individual conferences on assigned papers are required.
318. **Europe from 1914 to the Present: Power, Conflict, and the Cold War. 4 hours.** The contentions among facism, communism, and liberal democracy to re-

constitute Europe after 1918. The background of World War II and Europe in a cold war. Individual conferences on assigned papers are required.

319. **European Diplomatic History from 1648 to 1814. 4 hours.** The foreign policy of European states from the Treaty of Westphalia to the fall of Napoleon. Individual conferences on assigned papers are required.
320. **European Diplomatic History from 1814 to 1878. 4 hours.** The foreign policy of European states from the fall of Napoleon to the Congress of Berlin. Individual conferences on assigned papers are required.
321. **The Diplomacy of Imperialism from 1878 to the Present. 4 hours.** European relations with the non-European world: late nineteenth century imperialism, the creation, administration, and disintegration of colonial empires and the emergence of new nations in an age of decolonization. Individual conferences on assigned papers are required.
322. **The Scientific Revolution of the Seventeenth Century. 4 hours.** The emergence of modern science as a mode of thought; its implications for the history of early modern Europe. Individual conferences on assigned papers are required.
323. **Ideas and Ideologies in Nineteenth Century European Thought. 4 hours.** Major ideas and ideologies of Europe in the nineteenth century, from Romanticism to late-century Social Darwinism. Prerequisite: One year of modern European history.
324. **Ideas and Ideologies in Twentieth Century Thought. 4 hours.** Important intellectual trends in the modern world: Freudianism and the new science of man, Spenglerian "decline of the West," Marxism-Leninism, the irrationalism of fascism, the post-war existentialist dilemma. Prerequisites: Hist. 323 and one year of European history.
325. **Italian History from 1815 to 1870. 4 hours.** The impact of the French Revolution, the *Risorgimento*, the creation of the Italian nation-state and early years of the Kingdom of Italy. Individual conferences on assigned papers are required.
326. **Italian History from 1870 to the Present. 4 hours.** The development of the Italian national state: the political, social, and economic problems of Italy before World War I, the church-state relationship, colonial ambitions, the fascist corporate state, the Italian Republic since World War II. Individual conferences on assigned papers are required.
327. **German History from 1618 to 1740. 4 hours.** The Thirty Years' War: its political, economic, and social effects on German public life. The rise of absolutism, the decline of the *Reich*, economic reconstruction and cameralism, the changing structure of social relationships. Individual conferences on assigned papers are required.
328. **German History from 1740 to 1848. 4 hours.** The rise of Prussia and Austro-Prussian dualism; enlightened absolutism in Germany; Germany in the revolutionary period; the rise of political ideologies and middle-class culture; the revolutions of 1848. Individual conferences on assigned papers are required.
329. **Modern Germany from 1848 to the Present. 4 hours.** Germany's political, economic, and social reaction to the problems of national unification, industrialism, liberalism, world-power status, and rejuvenation after the loss of that status in the two World Wars. Individual conferences on assigned papers are required. Prerequisite: One year of European history or consent of the instructor.

331. **History of European Economic Life: 1750 to 1870. 4 hours.** The creation of industrial society in Britain and its diffusion to Western Europe. Prerequisite: Consent of the instructor.
332. **History of European Economic Life since 1870. 4 hours.** The continuing spread of industrial society throughout Europe since the climacteric of the 1870's; problems of mature capitalist societies and the emergence of a post-industrial economic order. Prerequisite: Consent of the instructor.
333. **History of East-Central Europe since 1526. 4 hours.** The political, social, economic, and cultural development of Austria, Hungary, Poland, and the Czechoslovak lands from the Battle of Mohacs to the present. Prerequisite: Consent of the instructor.
336. **European Intellectual History: The Age of Criticism, 1680 to 1750. 4 hours.** The Newtonian synthesis and its impact on the eighteenth century. The attack on authority, Bayle, Vico, Locke, the English Deists. The growth of scepticism, David Hume. The formation of Enlightenment philosophy, Montesquieu, Voltaire, and the first *philosophes*. Scientific academies, the salons, and the development of liberalism. Prerequisite: Consent of the instructor.
337. **Tudor England from 1485 to 1603. 4 hours.** The major political, constitutional, social, economic, and cultural developments and issues of Tudor England. Individual conferences on assigned papers are required.
338. **Stuart England from 1603 to 1714. 4 hours.** The major political, constitutional, social, economic, and cultural developments and issues of Stuart England. Individual conferences on assigned papers are required.
339. **Eighteenth Century England from 1714 to 1815. 4 hours.** From the accession of the Hanoverians to the end of the Napoleonic Wars. Individual conferences on assigned papers are required.
340. **Nineteenth Century England from 1815 to 1886. 4 hours.** From the end of the Napoleonic Wars to the Home Rule election. Individual conferences on assigned papers are required.
341. **Twentieth Century England from 1886 to the Present. 4 hours.** From the Home Rule election to the present. Individual conferences on assigned papers are required.
342. **Social and Economic Development of Modern Britain. 4 hours.** British economic developments since the Industrial Revolution; social and political response to industrial society; the rise of the Labour party and the welfare state. Individual conferences on assigned papers are required. Prerequisite: Hist. 133 or consent of the instructor.
343. **English Constitutional History to 1845. 4 hours.** The foundation and development of British constitutional, political, and legal institutions from Anglo-Saxon times to the accession of the Tudor dynasty. Individual conferences on assigned papers are required. Prerequisite: One year of British history or one year of medieval history or consent of the instructor.
344. **English Constitutional History from 1485 to the Present. 4 hours.** Growth, development, and change in British constitutional, political, legal, and imperial institutions from the accession of the Tudor dynasty to the present. Individual conferences on assigned papers are required. Prerequisite: One year of British history or one year of modern European history or consent of the instructor.



- 345. History of Western Africa and the Sudan. 4 hours.** Development of native African states from earliest times; the impact of European and other alien influences on the continent; the emergence of the modern independent African states. Individual conferences on assigned papers are required.
- 346. Eastern Africa and the Horn. 4 hours.** Development of native African states from earliest times; the impact of European and other alien influences on the continent; the emergence of modern independent African states. Individual conferences on assigned papers are required.
- 347. Southern Africa and the Congo. 4 hours.** Development of native African states from earliest times; the impact of European and other influences on the continent; the emergence of modern independent African states. Individual conferences on assigned papers are required.
- 348. The Portuguese Empire in Brazil. 4 hours.** Portuguese discovery, settlements, and exploitation of Brazil during three centuries; the creation of the Brazilian nation through an amalgamation of races and cultures in a plantation and mining economy.
- 349. Monarchy in Brazil from 1808 to 1889. 4 hours** The foundation of Brazilian independence; the consolidation of the nation; its economic, social, political, and intellectual development.
- 350. Modern Brazil from 1889 to the Present. 4 hours.** The conservative republic, the revolution of 1930, the Vargas era, economic, social, and cultural development, and the struggle for modernization.
- 351. Discovery and Settlement of the Americas in the Sixteenth and Seventeenth Centuries. 4 hours.** The development of the Americas; early phases of European interests in the Atlantic community; the first century of British North America. Individual conferences on assigned papers are required.
- 352. British North America from 1690 to 1765. 4 hours.** The duel with France for empire; the development of British North America to the eve of American independence. Individual conferences on assigned papers are required.
- 353. The Development of the American Nation from 1765 to 1801. 4 hours.** The background for independence, the American Revolution; the establishment of government. Individual conferences on assigned papers are required.
- 354. The New Nation: The United States from 1789 to 1828. 4 hours.** The establishment of the American nation under the constitution. Emergence of the political party system; westward expansion; the growth of nationalism and sectionalism. Individual conferences on assigned papers are required.
- 355. The Jacksonian Age: The United States from 1828 to 1848. 4 hours.** Political, social, and cultural developments during the middle period. Individual conferences on assigned papers are required.
- 356. Expansion and Conflict: The United States from 1848 to 1865. 4 hours.** Causes and events leading to the Civil War; Lincoln and the war. Individual conferences on assigned papers are required.
- 357. The Politics of Reform in Industrial America from 1877 to 1912. 4 hours.** Agrarian protest, organization of labor, third-party movements and progressivism in the period of rapid social and economic change at the turn of the century. Individual conferences on assigned papers are required.
- 358. Response to Crisis: Twentieth Century America in War and Depression from 1912 to 1939. 4 hours.** The American response to World War I and to the

depression of the 1930's. An analysis of political, social, economic, and intellectual tendencies. Individual conferences on assigned papers are required.

359. **Studies in Contemporary American History: The United States from 1939 to the Present. 4 hours.** World War II, post-war diplomacy, political, social, economic, and intellectual tendencies. Individual conferences on assigned papers are required.
360. **Reconstruction: The United States from 1865 to 1877. 4 hours.** Reconstruction of the Union following the Civil War. Individual conferences on assigned papers are required.
361. **The Land and the Nation. 4 hours.** Analysis of the influence of public domains on American development, from colonial times until the Civil War. Emphasis on political, institutional, constitutional, and ideological topics. Individual conferences on assigned papers are required.
362. **The United States and Its Natural Heritage. 4 hours.** Analysis of the contest that developed after 1865 for the control and utilization of America's natural resources. Emphasis on political, institutional, economic, social, and ideological topics. Individual conferences on assigned papers are required.
363. **American Intellectual and Social Thought from 1600 to 1830. 4 hours.** Representative cultural statements from American Puritanism, the Enlightenment, Romanticism, and Pragmatism. Individual conferences on assigned papers are required.
364. **American Intellectual and Social Thought from 1831 to 1890. 4 hours.** Representative cultural statements from American Puritanism, the Enlightenment, Romanticism, and Pragmatism. Individual conferences on assigned papers are required.
365. **Development of the American Economy from 1607 to 1815. 4 hours.** Analysis of the main currents and factors in the economic development of the United States from colonial times to the War of 1812. Special attention to the relationship of economic institutions and activities to social and political trends in American civilization. Individual conferences on assigned papers are required.
366. **Development of the American Economy from 1815 to 1917. 4 hours.** Analysis of the main currents and factors in the economic development of the United States from the War of 1812 to World War I. Special attention to the relationship of economic institutions and activities to social and political trends in American civilization. Individual conferences on assigned papers are required.
367. **The Diplomatic History of the United States from 1775 to 1880. 4 hours.** The development of American relationships in the New World and with the nations of Europe and Asia. Individual conferences on assigned papers are required.
368. **The Diplomatic History of the United States from 1880 to the Present. 4 hours.** The emergence of the United States as a world power. Individual conferences on assigned papers are required.
369. **Constitutional Development of the United States to 1840. 4 hours.** Individual conferences on assigned papers are required. Prerequisite: One year of United States history or British history or political science.
370. **Constitutional Development of the United States from 1840 to 1900. 4 hours.** Individual conferences on assigned papers are required. Prerequisite: One year of United States history or British history or political science.



- \*371. **Constitutional Development of the United States in the Twentieth Century. 4 hours.**
372. **Development of the American Economy from 1917 to the Present. 4 hours.** Analysis of the main currents and factors in the economic development of the United States since World War I. Special attention to the relationship of economic institutions and activities to social and political trends in American civilization. Individual conferences on assigned papers are required.
373. **American Urban History: The Colonial Period to the 1860's. 4 hours.** The major causes for and the consequences of the emergence of American cities from the seventeenth century to the Civil War. Individual conferences on assigned papers are required. Prerequisite: One year of introductory American history or consent of the instructor.
374. **American Urban History: The 1860's to the Present. 4 hours.** The major causes for and the consequences of the emergence of the industrialized city: industrial revolution, labor movement, architectural revolution, ethnic groups, housing, health, social reform, and others. Individual conferences on assigned papers are required. Prerequisite: One year of introductory American history or consent of the instructor.
375. **Studies in American Urban History. 4 hours.** Individual training in research in urban history and discussion of selected major problems of American urbanization. Individual conferences on assigned papers are required. Prerequisites: Hist. 373 and 374 or consent of the instructor.
376. **American Intellectual and Social Thought from 1891 to the Present. 4 hours.** Representative cultural statements from American Puritanism, the Enlightenment, Romanticism, and Pragmatism. Individual conferences on assigned papers are required.
377. **American Racial History to the Civil War. 4 hours.** The history of race relations in America, with an especial emphasis on Negro-White relations, American Negro history and the manner in which concern for race has been transformed into issues of national importance from the earliest Western contacts with Africa through the Abolitionist era. Individual conferences on assigned papers are required. Prerequisite: One year of introductory American history or political science or sociology or consent of the instructor.
378. **American Racial History since the Civil War. 4 hours.** The history of race relations in America, with an especial emphasis on Negro-White relations, American Negro history, and the manner in which concern for race has been transformed into issues of national importance from the Civil War to the present day. Individual conferences on assigned papers are required. Prerequisite: One year of United States history or political science or sociology or consent of the instructor.
379. **Studies in American Racial History. 4 hours.** A seminar that emphasizes original research in selected topics on American racial history. Prerequisites: Hist. 377 and 378 or consent of the instructor.
381. **Greek History from 750 to 478 B.C. 4 hours.** The political, social, and economic development of Greece from the end of the Dark Ages to the defeat of the Persian invader. Prerequisite: Hist. 282 or consent of the instructor.
383. **The Roman Revolution from 146 to 30 B.C. 4 hours.** The political, social, and economic history of Rome from the Gracchan crisis to the end of the Republic. Prerequisite: Hist. 283 or consent of the instructor.

\*Approval pending.



384. **The Roman Empire, the Second through the Sixth Centuries, A.D. 4 hours.** The Roman Empire as a bridge between antiquity and medieval civilization. The decay of imperial institutions as a result of social tensions and economic problems and attempts at imperial reform. Christianity in the empire and the rise of the papacy. The Germanic invasions and the establishment of the western kingdoms. Individual conferences on assigned papers are required.
387. **European Intellectual History: The High Enlightenment (1750 to 1799). 4 hours.** The Enlightenment synthesis. The problem of the Enlightenment. Materialism, mechanism, egoism, fatalism. The *Encyclopedia*; liberalism and the crusade against social injustice; Rousseau and the revolt against the Enlightenment; primitivism, sentiment, and the beginnings of Romanticism. The Enlightenment in Germany. The impact of Enlightenment on the French Revolution. Prerequisite: Hist. 386 or consent of the instructor.
388. **Greek and Roman Historiography. 4 hours.** Analysis of the most important historians of classical antiquity, including their backgrounds, motives, interests, techniques, prejudices, and philosophies of history. Prerequisite: Hist. 282 or 283 or consent of the instructor.
389. **The American Historians from 1607 to 1876. 4 hours.** Major American historians; analysis of their works as expressions of American culture. Emphasis on the role which history has played in American life and thought. Individual conferences on assigned papers are required.
390. **Proseminar in American History. 4 hours.** May be repeated for credit. Selected topics for special study. Individual conferences on assigned papers are required.
391. **The American Historians from 1877 to the Present. 4 hours.** Major American historians; analysis of their works as expressions of American culture. Emphasis on the role which history has played in American life and thought. Individual conferences on assigned papers are required.
392. **Proseminar in Modern European History. 4 hours.** May be repeated for credit. Selected topics for special study. Individual conferences on assigned papers are required.
393. **Proseminar in East-European History. 4 hours.** May be repeated for credit. Selected topics for special study. Prerequisite: Consent of the instructor.
394. **Proseminar in English History. 4 hours.** May be repeated for credit. Selected topics for special study. Individual conferences on assigned papers are required.
395. **Proseminar in Medieval History. 4 hours.** May be repeated for credit. Selected topics for special study. Individual conferences on assigned papers are required.
396. **Proseminar in Russian History. 4 hours.** May be repeated for credit. Selected topics for special study. Individual conferences on assigned papers are required.
398. **The Development of Modern France: 1914 to the Present. 4 hours.** An investigation into the major political and socio-economic forces at work in French history from the First World War to General Charles de Gaulle's Fifth Republic; the uniqueness and the universality of the French experience are stressed. Prerequisite: Consent of the instructor.
399. **Topics in Modern French History. 4 hours.** A thematic approach to the major political, social, and economic forces in modern French history; revolution; the classes and the masses; Marxism; the military; bureaucracy; technocracy; political parties and ideologies; Gaullism. Prerequisite: Consent of the instructor.

# MATERIALS ENGINEERING

## Professors

Ernest F. Masur, Head of the Department; Thomas H. Blewitt, David W. Levinson, William Rostoker, John A. Schey, Robert L. Schiffman.

## Associate Professors

Robert F. Domagala, James M. Doyle, Gordon H. Geiger, Daniel F. Schoeberle, Albert B. Schultz, Thomas C. T. Ting.

## Assistant Professors

Robert H. Bryant, Mahmoud Khojasteh, Walid H. Rimawi, Surendra P. Shah, Otto E. Widera, Chien-Heng Wu.

The department offers a program leading to the degree of Master of Science in Mechanics and Materials. This program covers a broad range of topics and may be used either as a terminal program for those wishing to seek employment after completing the M.S. or as a basis for further studies leading to the Ph. D.

The courses offered within this program cover topics which are relevant to many professional disciplines. Because of extensive freedom in course selection, a student may prepare himself for a career in such diverse areas as metallurgy, soil mechanics and foundations, structures, and engineering mechanics. Interdisciplinary programs are permitted and encouraged.

After admission to the graduate school, the student is assigned to a departmental adviser with whom a tentative course program is established. This may be revised periodically in consultation with the adviser. The student is also urged to prepare himself as early as possible for his thesis work and to make his course selection accordingly.

Although the student has almost complete latitude in the choice of his course work, the following areas of specialization and proposed course sequences are listed as examples and guides:

Engineering Mechanics:	301, 302, 303, 311, 331, 402, 404, 411, 431, 499, (333, 341, 403, 432, 441).
Metallurgy:	301, 303, 331, 332, 333, 432, 433, 434, 499, (334, 342, 403, 404, 435).
Structures:	302, 321, 322, 323, 333, 421, 422, 432, 442, 499, (341, 402, 404, 423).
Soils and Foundations:	341, 342, 343, 344, 345, 346, 441, 442, 443, 447, 499, (301, 303, 403).

(Course numbers in parentheses are listed as suggested alternatives.)

## Admission Requirements

Graduates from recognized engineering colleges will be admitted if they have maintained a grade-point average of B (4.00) or better in undergraduate study. Those with lower averages may be admitted upon special recommendation of the department, providing they satisfy the minimum requirements of the

Graduate College. Practicing engineers wishing to return to school for further graduate instruction may be admitted on a tentative basis if their professional experience makes it appear likely that they will be able to follow the program successfully. This tentative admission will become permanent after the successful completion of at least 16 quarter hours of courses with an average of 4.00 or better.

## Degree Requirements

A grade-point average of at least 4.00 is required; credit toward the degree for graduate students majoring in materials engineering is not given for any course in which a grade of less than C has been obtained. Forty-eight quarter hours are required, with a minimum of 16 hours in courses at the 400 level. The following minimum requirements are also imposed:

- a. The successful completion of at least two courses in mathematics (as agreed to with the student's adviser).
- b. The successful completion of a thesis, research project, design project, or extensive reading assignment to be followed by a written report and an oral examination. For this work the student will receive credit for at least 4 and not more than 8 quarter hours.
- c. The successful completion of a minimum of two courses in each of the materials and mechanics groups. These acceptable "core courses" will be selected from among the departmental offerings.

The thesis for the degree of Master of Science need not represent an original contribution. Rather, it is intended to acquaint a student with the process of concentration on one subject in depth. Accordingly, a student may satisfy the thesis requirement by selecting a particular topic of interest and by making a thorough search of the available literature on that subject. Or he may select a design problem involving extended studies and the making of choices. Again, a significant laboratory experience may form the basis of the student's work. The results of the investigation will be described in a report which will be graded and which the student must defend in an oral examination before a committee consisting of members of the Department of Materials Engineering.

## Courses for Graduate Students

- \*401. Continuum Mechanics. 4 hours.** Kinematics and dynamics of continua. Conservation principles, constitutive relations. Approximations. Prerequisite: MatE. 301.
- 402. Applied Elasticity II. 4 hours.** Development of classical plate equation and boundary conditions; solution of problems in rectangular and polar coordinates; energy principles; plates with variable thickness; large deflection theory; effect of shear deformations. Prerequisite: MatE. 302.
- 403. Theory of Elasticity II. 4 hours.** Review of complex variable theory, application to torsion, bending, and plane problem. The general three-dimensional problem, stress functions, singularities. Introduction to elastokinetics. Prerequisite: MatE. 303.

\*Approval pending.



404. **Plasticity I. 4 hours.** Basic postulates of plasticity. Yield conditions and associated flow laws. Torsion of cylindrical and prismatic bars. Generalized stresses and strain rates. Theorem of limit analysis. Application of limit analysis to plane problems, plates, and shells. Prerequisite: MatE. 301.
406. **Theory of Shells. 4 hours.** Differential geometry; geometry of deformation; equations of equilibrium; energy theories; membrane theory; general bending theory. Application to shells of different geometry. Prerequisites: MatE. 302 and Math. 322.
408. **Theory of Viscoelasticity. 4 hours.** Establishment of the field equations of viscoelastic materials and mathematical techniques of solving these equations. Prerequisites: MatE. 303 and Math. 322.
411. **Vibrations of Structural Elements. 4 hours.** Analytic and numerical treatment of vibrations in elastic strings, beams, plates, etc. Prerequisites: MatE. 302 and Math. 322.
412. **Vibrations and Waves in Solids. 4 hours.** Mathematical and experimental treatment of waves in elastic and inelastic solid media. Prerequisites: MatE. 303 and Math. 322.
421. **Structural Analysis III. 4 hours.** Application of matrix, numerical, and computer techniques to the analysis of complex structural systems. Prerequisite: MatE. 321 or the equivalent.
422. **Mechanics of Reinforced Concrete. 4 hours.** Introduction to composite materials; properties of steel, concrete, and the bond between steel and concrete. Elastic, inelastic, and post-failure behavior of reinforced concrete members. Effects of continuity. Effects of time. Probabilities of uncertainties of materials and loadings. Analysis of design codes. Prerequisite: MatE. 322.
423. **Elastic Instability I. 4 hours.** Principles of elastic instability and their analytical, numerical, and experimental treatment. Buckling of columns, frames, rings. Lateral and torsional instability. Prerequisite: MatE. 302. A knowledge of partial differential equations is required.
424. **Elastic Instability II. 4 hours.** General discussion: Small displacements superimposed on finite deformations; application to plates and shells; post-buckling analysis; dynamic instability. Prerequisite: MatE. 423. A knowledge of partial differential equations is required.
432. **Dislocation Theory. 4 hours.** Nature of dislocation in crystals. Static and dynamic behavior. Interaction with solute atoms, precipitates, and other dislocations. Effect on mechanical properties. Dislocation interactions, reductions, and dislocation arrays. Prerequisite: MatE. 301 or consent of the instructor.
433. **Advanced Mechanical Metallurgy. 4 hours.** A study of mechanical flows of metals and alloys from the standpoint of continuum mechanics. Application to basic metal-forming operations. Prerequisite: MatE. 301 or consent of the instructor.
434. **Advanced Experimental Methods. 4 hours.** First of two courses covering the theoretical and operational aspects of advanced materials research methods at an advanced level. Design of complex experimental devices. Applications and limitations. Treatment of data. Prerequisite: MatE. 230 or consent of the instructor.

- 441. Mechanics of Multiphase Systems. 4 hours.** Three-dimensional theory of multiphase media including effects of applied forces, thermo-osmosis, electro-osmosis, and chemical potentials. Three-dimensional theory of consolidation; derivation, solution by analytical and numerical means. Analysis of three-dimensional consolidation effects. Prerequisites: MatE. 301 and 341.
- 442. Strength and Deformation Theories of Soil. 4 hours.** Theories of plasticity as applied to soil mechanics. Problems of limiting equilibrium. Application of plasticity theories to problems of bearing capacity, earth pressure, and slope stability. Mechanics of granular systems. Prerequisites: MatE. 301 and 341. A knowledge of partial differential equations is required.
- 447. Advanced Soil Engineering I. 4 hours.** Analysis of displacements of structures due to earth deformation. Site exploration; analysis of foundation types; shallow and deep foundations; settlements; bearing capacity. Retaining structures. Prerequisite: MatE. 261.
- 493. Special Problems (Graduate). 1 to 4 hours.** Special topics, seminars, or other special activities.
- 499. Thesis Research. 0 to 16 hours.** Individual research: Reading, design, analytical studies, or laboratory assignments. Culminates in report or Master's thesis. Examination of report or thesis required.

## Courses for Graduate and Advanced Undergraduate Students

- 301. Introduction to the Mechanics of Continua. 4 hours.** Vectors and tensors and their component properties in Cartesian coordinates. The displacement and velocity vectors, the stress and strain tensors and their time rates. Isotropic and deviatoric components. Equations of equilibrium and of compatability. Constitutive relations for linear elastic and viscous bodies and generalized linear viscoelastic behavior. Isotropy. Introduction to perfect plasticity. Sample problems for all cases by means of simple one-dimensional models. Prerequisite: MatE. 103 and Math. 220 or consent of the instructor.
- 302. Applied Elasticity I. 4 hours.** Variational theorems of elasticity theory. Application to establishment and solution of approximate systems: beams (including shear deformations) and plates. Introduction to instability theory. Prerequisite: MatE. 205 or 206.
- 303. Theory of Elasticity I. 4 hours.** The boundary value problems of linear isotropic elasticity theory. Uniqueness of solution. Reduction to two dimensions: the plane problem, torsion, bending. General orthogonal coordinates and special application to polar coordinates. Three-dimensional problems with axial symmetry. Prerequisite: MatE. 301.
- 311. Intermediate Dynamics. 4 hours.** Kinematics of a point, space curves. Particle dynamics, orbital motion, and stability. Moving reference frames. Rigid body dynamics: the inertia tensor, Euler's equations, application to gyroscopic motion. Hamilton's principle. Generalized coordinates. Lagrange's equations. Prerequisite: MatE. 102 and Math. 220 or consent of the instructor.
- 312. Nonlinear Oscillations. 4 hours.** Exact and approximate methods of studying vibrations of nonlinear systems. Analytical and graphical techniques. Forced oscillation, self-excited systems, stability criteria. Computer methods. Practical applications. Prerequisite: MatE. 208.
- 313. Applied Dynamics. 4 hours.** Application of principles of dynamics to engineering physics. Balancing; rolling and sliding contact, static and dynamic force analyses

of machine elements. Critical speeds. Impact loading. Prerequisites: MatE. 208 and 209 or consent of the instructor.

- 321. **Structural Analysis II. 4 hours.** Establishment of basic equations governing linear structural systems. Matrix inversion and relaxation solutions. Approximate analyses. Introduction to dynamics of structures. Prerequisite: MatE. 207.
- 322. **Concrete Technology I. 4 hours.** Relations between microproperties and macroproperties; mechanisms of fracture, creep, and shrinkage; statistical aspects; air entrainment; special types of concrete. Individual research project involving laboratory and analytic techniques. 3 hours, lecture; 2 hours, laboratory. Prerequisite: MatE. 203 or the equivalent.
- 324. **Limit Analysis and Design of Structures. 4 hours.** Boundedness principles of perfect plasticity. Application to analysis and design of structures. Prerequisite: MatE. 207.
- 331. **Election Theory of Metals. 3 hours.** Modern physical concepts of metals and alloys. Introduction to wave mechanics. Thermal, electrical, and magnetic properties of metals. Band theory of metals. Prerequisite: MatE. 252.
- 332. **Advanced Diffraction Analysis. 3 hours.** Single crystal methods in X-ray diffraction, orientation determination, pole figures, structure determination, precision lattice constant methods. Prerequisite: MatE. 239 or the equivalent.
- 333. **Design Use of Materials. 4 hours.** Methods of measurement and significance of tests for service properties. Selection of materials for specific applications. Case histories. Prerequisite: MatE. 230.
- 334. **Metallurgy of Nuclear Materials. 3 hours.** Uses of materials for the production of nuclear energy, environmental problems associated with radiation damage, mechanical and physical property changes, swelling, poisoning, fission, moderation, neutron capture, and latent activity. Prerequisites: Phys. 114 and MatE. 252.
- 335. **Electron Microscopy. 3 hours.** The electron microscope and its application to the study of surface replicas and thin films of metals, alloys, and other materials. Sources of contrast. Selected area diffraction. Prerequisites: MatE. 239 and 252.
- 341. **Theoretical Soil Mechanics I. 3 hours.** Theories used in soil mechanics. Derivation of theoretical relationships and theoretical implications of empirical laws. Theories of deformation of soil systems: states of stress and deformation in soil masses; one-dimensional theory of consolidation for homogeneous and nonhomogeneous clay layers; seepage as a function of isotropy and homogeneity. Prerequisite: MatE. 202 or the equivalent.
- 342. **Theoretical Soil Mechanics II. 4 hours.** Stresses and displacements in earth masses. The analysis of layered systems: analytical, finite difference, finite element methods. Settlement analysis: soil-structure interaction. Analysis of structural response of flexible and rigid pavements. Development of problem oriented computer languages for settlements. Prerequisites: MatE. 341 and Math. 322.
- 343. **Theoretical Soil Mechanics III. 4 hours.** Seepage through earth masses: derivation of basic equations; analytical and numerical methods of solution; rapid drawdown. Stability of earth slopes: derivation of basic relationships; methods of Fellenius, Bishop, Morganstern. Computer methods for slope stability and seepage; problem-oriented languages. Prerequisite: Math 322.



- 391. Seminar. 1 hours.** Topics to be arranged. Prerequisite: Consent of the instructor.
- 393. Special Problems. 2 to 4 hours.** Special problems or reading by special arrangement with the faculty. Prerequisite: Consent of the instructor.

## **MATHEMATICS**

### **Professors**

Joseph Landin, Head of the Department; Norman Blackburn, Herbert J. Curtis, Flora Dinkines, Philip Dwinger, Irwin K. Feinstein, Evelyn Frank, Henry L. Garabedian, Victor K. A. M. Gugenheim, Noburu Ito, Louis L. Pennisi, Robert L. Taylor, Victor Twersky.

### **Associate Professors**

Furio Alberti, Warren H. Brothers, Djairo De Figueiredo, Paul Fong, Norman T. Hamilton, William A. Howard, Shmuel Kantorovitz, R. James Milgram, Reuben Sandler, W. Forrest Stinespring, Avrum I. Weinzwieg.

### **Assistant Professors**

Ruth M. Ballard, James A. Donaldson, Verena H. Dyson, David A. Foulser, Brayton I. Gray, Morton E. Harris, Richard G. Larson, Jeff E. Lewis, Alan McConnell, James W. Moeller, Pramod K. Pathak, Arthur Pu, Lena C. Pu, Yoram Sagher, Alexander P. Stone, Alexander Zabrodsky.

The Department of Mathematics offers graduate work leading to the Master of Arts or Master of Science in Mathematics, the Master of Science in the Teaching of Mathematics, and the Doctor of Philosophy in Mathematics.

## **Admission Requirements**

Applicants must have a grade-point average of 3.75. The average is computed from the last 90 quarter hours of work completed, including undergraduate and graduate courses. Students with averages below 3.75 but above 3.50 are considered on an individual basis. An applicant must also have a 4.00 average in all mathematics courses beyond calculus.

Students should have 30 quarter hours of undergraduate work in mathematics besides the usual beginning courses in algebra, trigonometry, analytic geometry, and calculus. For the Master's degree in mathematics these must include one year of work in analysis (equivalent to Mathematics 310, 311, 312) and one year of work in an introduction to higher algebra (equivalent to Mathematics 340, 341, 342). The remaining hours should be in mathematics courses at the 300 level (or their equivalents). For the Master's degree in the Teaching of Mathematics, Mathematics 310, 340, 341 and either 342 or 348 (or the equivalent) are required for admission.

Applicants are required to take the Graduate Record Examination (Verbal, Quantitative, and Advanced) and to submit three letters of recommendation

from persons familiar with their academic work. If a candidate is admitted with deficiencies in courses normally required for admission, he must remove such deficiencies during the first three quarters of his attendance. No graduate credit is given for such courses. A student who has done graduate work at a recognized institution may petition to receive credit for such work.

## Degree Requirements

*Master of Arts and Master of Science:* 48 quarter hours are required for the degree. Of these at least 36 must be in mathematics, including at least 20 in approved 400-level courses. Mathematics 332 and 333 (or Mathematics 330 and 331) and Mathematics 355 are required. (This requirement may be fulfilled by previous undergraduate work.) A thesis is not required.

*Master of Science in the Teaching of Mathematics.* Candidates must earn 24 quarter hours of credit in mathematics, 12 in education or psychology, and 12 in electives. Candidates must have completed Mathematics 311, 312, and 342. The requirement in psychology may be satisfied by taking 12 quarter hours from among the following: Psychology 317, 323, 351, 354, 355, or 382. When the College of Education offers appropriate courses, the requirements in psychology and in education may be met by such courses.

The electives may be in mathematics, in education, in psychology, or (in exceptional cases) in other fields. The advisers for candidates for this degree are Professors Irwin K. Feinstein and Alice Hart.

*Doctor of Philosophy.* The departmental requirements for the doctorate are as follows. The student must take a written qualifying examination based on material required by the department for the Master's degree. The department will advise each student to take this examination according to his educational progress, but it should be taken no later than one year after completion of the Master's degree or its equivalent. In special circumstances the department may relax this time limit.

The student will choose a major subject from the following: algebra, analysis, applied mathematics, geometry, or topology. The student must also choose two internal minors from the preceding list or one internal minor and one outside minor. The choice of an outside minor, whether split or full, must have the approval of the Mathematics Department. The requirements for such a minor should be checked with the department concerned. The student will present at least 60 quarter hours in 400-level mathematics courses, unless he has opted a full outside minor, which requires 48 hours. At least three 400-level courses are required for each internal minor. Courses must have the approval of the department. Each student is required to have 144 hours of graduate credit, of which 48 hours will usually be thesis credit.

Each student will take a preliminary (oral) examination within one year of completing 96 quarter hours of graduate work, including work for the Master's degree. The department may, in special circumstances, relax this time limit. The examination will be based on the student's major and internal minor subjects; it will also test the breadth of his knowledge of mathematics. The student must

demonstrate reading proficiency in any two of the following languages: French, German, or Russian.

Since the doctoral program is intended to be training in mathematical research and scholarship, the crucial effort is the production of a thesis. With the guidance of the department, the student will write a thesis that is a significant piece of mathematical research acceptable to the department.

## Courses for Graduate Students

- 401. Second Course in Abstract Algebra I. 4 hours.** Isomorphism theorems, permutation groups, finite groups, Sylow's theorems, structure of finitely-generated Abelian groups, composition series, solvable groups. Prerequisite: Math. 342 or the equivalent.
- 402. Second Course in Abstract Algebra II. 4 hours.** Field extensions, finite fields, Galois theory, Wedderburn's theorem. Prerequisite: Math. 401.
- 403. Second Course in Abstract Algebra. 4 hours.** Rings and algebras, structure of algebras, multilinear algebra, tensor products. Prerequisites. Math. 402.
- \*404. Rings and Modules. 4 hours.** The category of  $R$ -modules, projective and injective modules, the Morita theorems, elementary homological algebra, separable algebras, homological dimension. Prerequisite: Math. 403 or consent of the instructor.
- \*405. Finite Groups. 4 hours.** Transfer theorems,  $p$ -nilpotent groups,  $E_\pi$ ,  $C_\pi$ ,  $D_\pi$  properties, solvable groups, Schur-Zassenhaus theorem, additional topics selected by the instructor. Prerequisite: Math. 403 or consent of the instructor.
- \*406. Free Groups and Universal Properties. 4 hours.** Universal algebras, words and varieties, free algebras, free groups, subgroups of free groups, free products, free associative algebras, Birkhoff-Witt theorem, free Lie algebras. Prerequisite: Math. 403 or consent of the instructor.
- \*407. Representation Theory. 4 hours.** Representation theory of finite dimensional algebras, structure of the regular representation, characters, applications to finite groups, theorems of Frobenius and Burnside, character ring, exceptional characters. Prerequisite: Math. 403 or consent of the instructor.
- \*408. Homological Algebra I. 4 hours.** Abstract categories, examples, monics and epics, functors duality, natural transformations, natural equivalences and adjoints, products and coproducts and quotient objects, additive categories, additive functors, kernels and cokernels, Abelian categories, functor categories. Prerequisite: Math. 403 or consent of the instructor.
- \*409. Homological Algebra II. 4 hours.** Complexes, homology, exactness of functors, projectives and injectives, direct and inverse limits, generators and cogenerators, connected sequences of functors, universal connected sequences of functors, satellites of a functor, resolutions, derived functors, ext tor, the full embedding theorem. Prerequisite: Math. 408.
- \*410. Nonassociative Algebras I. 4 hours.** Introduction to nonassociative algebras, alternative algebras, power associative algebras, Jordan algebras. Prerequisite: Math. 403 or consent of the instructor.

\*Approval pending.



- \*411. Nonassociative Algebras II. 4 hours.** Jordan algebras continued, Lie algebras, general classification theorems. Prerequisite: Math. 410.
- 419. Advanced Topics in Algebra. 4 hours.** May be repeated for credit. Special topics in algebra. Prerequisite: Consent of the instructor.
- 421. Algebraic Topology I. 4 hours.** The category of topological spaces and functors, homology of complexes, singular homology theory, Eilenberg-Steenrod axioms, C-W complex, cohomology and cup-products, universal coefficient theorem, Kunneth theorem. Prerequisites: Math. 357 or equivalent and Math. 342.
- 422. Algebraic Topology II. 4 hours.** Homotopy groups, Hurewicz theorem, Whitehead theorem, fibre spaces, Postnikov sections, obstruction theory, Serre spectral sequence, e-theory, applications. Prerequisite: Math. 421.
- 423. Algebraic Topology III. 4 hours.** Freudenthal suspension theorem, stable homotopy theory, cohomology operations, construction and cohomology of Eilenberg-MacLane spaces, structure of the Steenrod-algebra, Adams spectral sequence. Prerequisite: Math. 422.
- \*424. Algebraic Topology IV. 4 hours.** H-spaces, classifying spaces, Steenrod-Dold-Lashof classification theorems for fibre spaces, Eilenberg-Moore spectral sequence, cohomology of the classical groups, Grassman manifolds, Steifel manifolds, Thom complexes. Prerequisite: Math. 423.
- \*425. Algebraic Topology V. 4 hours.** Generalized cohomology theories, K-theory, Bott periodicity, Chern character, operations in K-theory, Hopf invariant 1, vector fields on spheres. Prerequisite: Math. 424.
- \*426. Algebraic Topology VI. 4 hours.** Homotopy groups, differentials in the Adams spectral sequence, EHP sequence, Toda brackets, calculational methods. Prerequisite: Math. 425.
- 429. Advanced Topics in Topology. 4 hours.** May be repeated for credit. Special topics in topology. Prerequisite: Consent of the instructor.
- 430. Real Analysis I. 4 hours.** Set theory, well-ordering, cardinal and ordinal numbers, metric spaces, connectedness, compactness, completeness. Prerequisite: Math. 312.
- 431. Real Analysis II. 4 hours.** Riemann Stieltjes integral and its extension, measures and measurable sets, measurable functions, the Lebesgue integral. Prerequisite: Math. 430.
- 432. Real Analysis III. 4 hours.** Function spaces, differentiable and nondifferentiable functions, absolutely continuous functions. Prerequisite: Math. 431.
- \*433. Integral Equations. 4 hours.** Fredholm and Hilbert-Schmidt theory and applications, symmetric kernels and orthogononal systems of functions, some types of singular and nonlinear integral equations. Prerequisite. Math. 312 or consent of the instructor.
- \*434. Transform Methods. 4 hours.** Mellin and Hankel transforms, multiple Fourier transforms; applications to conduction of heat in solids, to slowing down of neutrons in matter, and to atomic and nuclear physics. Prerequisite: Math. 312, 331 or 333, or consent of the instructor.

\*Approval pending.

- 435. Calculus of Variations. 4 hours.** Introductory problems; geodesics, the brachistochrone, minimal surface of revolution. Isoperimetric problems. Geometrical optics, Fermat's principle. Dynamics of particles. Minimum characterization of the eigenvalue-eigenfunction problem. Ritz's method of approximation. Prerequisite: Math. 312 or consent of the instructor.
- 436. Functional Analysis I. 4 hours.** Topological vector spaces, Banach spaces, Hilbert spaces, Hahn-Banach theorem, interior mapping principle, uniform boundedness principle, applications, approximation and closure theorems. Prerequisite: Math. 432. or consent of the instructor.
- 437. Functional Analysis II. 4 hours.** Linear operators on a Banach space, the spectrum and resolvent of a linear operator, compact operators, spectral theorem for compact Hermitian operators on a Hilbert space, integral equations, Sturm-Liouville theory. Prerequisite: Math. 436.
- 438. Functional Analysis II. 4 hours.** Spectral theorem for normal operators on a Hilbert space, unbounded operators, semigroups of linear operators, ergodic theorems,  $H_p$  spaces of analytic functions, Beurling's theorem on the shift operator, applications. Prerequisite: Math. 437.
- \*439. Advanced Theory of Functions of a Complex Variable I. 4 hours.** Proofs and applications of some of the hallmark theorems associated with Phragmen, Lindeloff, Runge, Picard, and Riemann; abstract Riemann surfaces and their global uniformization. Prerequisites: Math. 333 and consent of the instructor.
- \*440. Advanced Theory of Functions of a Complex Variable II. 4 hours.** Compact Riemann surfaces, the Riemann-Roch theorem, the duality between compact Riemann surfaces and finitely generated extensions of the complex numbers of transcendence degree one. Prerequisite: Math. 439.
- 449. Advanced Topics in Analysis. 4 hours.** May be repeated for credit. Special topics in analysis. Prerequisite: Consent of the instructor.
- 450. Projective Geometry I. 4 hours.** Coordinatization, collineation groups, Desargues' condition, weakened forms of Desargues' condition and corresponding coordinate systems, fundamental theorem of projective geometry. Prerequisite: Consent of the instructor.
- 451. Projective Geometry II. 4 hours.** Finite planes, free planes, collineations of division ring planes and of free planes, the Lenz-Barlotti classification. Prerequisite: Math. 450.
- 452. Differential Geometry I. 4 hours.** Manifolds, tensor fields, the tensor algebra, the Grassman algebra, exterior differentiation, mappings, transformations of vector fields and differential forms, affine connections, parallelism, the exponential mappings, covariant differentiation. Prerequisite: Consent of the instructor.
- \*453. Differential Geometry II. 4 hours.** The Riemannian connection, complete Riemannian manifolds, isometries, curvature, Lie groups. Prerequisite: Math. 452.
- \*454. Structure of Differentiable Manifolds I. 4 hours.** Tangent bundle, vector fields, tensors, differentiable mappings, geodesics, exponential mapping, Whitney embedding theorem, Morse theory. Prerequisites: Credit or registration in Math. 421 and 430 or consent of the instructor.

\*Approval pending.

- \*455. Structure of Differentiable Manifolds II. 4 hours.** De Rham theorem, duality, vector bundles, characteristic classes, Hirzebruch index theorem, almost complex structures, Milnor spheres. Prerequisite: Math. 454.
- \*456. Structure of Differentiable Manifolds III. 4 hours.** Poincare conjecture, structures on manifolds, cobordism theorem, embeddings and immersions, Atiyah-Singer index theorem, Lie groups and Lie algebras, Bott periodicity theorem. Prerequisite: Math. 455.
- 459. Advanced Topics in Geometry. 4 hours.** May be repeated for credit. Special topics in geometry. Prerequisite: Consent of the instructor.
- 470. Probability Theory I. 4 hours.** Measure-theoretic aspects of probability theory, characteristic functions, the inversion theorem, the Levy-Cramer continuity theorem, Bochner's theorem, Cramer's theorem and the Herglotz lemma, types of convergence, the Borel-Cantelli lemma, the zero-one law, the law of large numbers, central limit theorems of Lindeberg, Liapunov, and Lindeberg-Feller. Prerequisite: Math. 432 or consent of the instructor.
- 471. Probability Theory II. 4 hours.** The central limit problem, conditional probability, martingales, random walk and recurrent events, Markov processes with discrete and continuous parameters, general introduction to processes, least square prediction. Prerequisite: Math. 470.
- 480. Scattering Theory I. 4 hours.** Solutions of the reduced wave equations for scattering of scalar, vector, and dyadic waves; separable and nonseparable problems. Representations; Green's function integrals, complex integrals, inverse distance series, special function series; approximations; geometrical optics and potential theory; applications. Prerequisites: Math. 323, 331, and Phys. 371 or consent of the instructor.
- 481. Scattering Theory II. 4 hours.** Representations, theorems, and approximations for many-body problems. Multiple scattering solutions as functionals of single body functions: integral equations, algebraic equations, series representations, operational closed forms, asymptotic forms. Two-scatterer problems, arbitrary figurations and periodic arrays. Prerequisite: Math. 480.
- 482. Scattering Theory III. 4 hours.** Statistical scattering problems. Scattering by randomly moving distributions. Models for scattering by rough surfaces, gases, and liquids. Relations between scatterer statistics and signal statistics for low-speed distributions. Relativistic scattering problems. Prerequisite: Math. 481.
- 484. Mathematical Techniques of Nuclear Reactor Theory I. 4 hours.** Same as EnrE. 484. Introduction to nuclear physics and nuclear reactor physics; flux distributions, critical mass, slowing down kernels and their Fourier transforms, two-group steady state theory in the reflected reactor, buckling iteration method, matrix methods in boundary value and criticality problems in the one-dimensional multiregion reactor, series solutions of group diffusion equations in multiregion reactor and in two-dimensional fully reflected reactor, reactor criticality codes. Prerequisites: Math. 312, 323, 341 or 348, and 381 or equivalent; or consent of the instructor.
- 485. Mathematical Techniques of Nuclear Reactor Theory II. 4 hours.** Same as EnrE. 485. Variational methods in the criticality problem, theory of control rods in cylindrical reactor, introduction to reactor kinetics, perturbation theory

\*Approval pending.



and applications, adjoint flux distributions, inhour equation for multiregion multifuel reactors, xenon poisoning and override problem. Prerequisite: Math. 484.

- 486. Mathematical Techniques of Nuclear Reactor Theory III. 4 hours.** Same as EnrE. 486. Cylindrical reactor with source, power level determination problem, time-dependent flux distributions in multiregion reactor, one-group model, transient and stable flux distributions in multiregion reactor, two-group model, self-limiting power bursts, analysis of nonlinear feedback problems. Prerequisite: Math. 485.
- 489. Advanced Topics in Applied Mathematics. 4 hours.** May be repeated for credit. Special topics in applied mathematics. Prerequisite: Consent of the instructor.
- 499. Thesis Research. 0 to 16 hours.** Prerequisite: Consent of the instructor.

### Courses for Graduate and Advanced Undergraduate Students

- 300. Teachers Course I. 4 hours.** Important mathematical concepts and problems involved in teaching them; treatment of numeration system, set relations, functions, whole numbers, logic, and proof; examination of some of the major new curricula. Prerequisite: Math. 133 or consent of the instructor.
- 301. Teachers Course II. 4 hours.** Continues Math. 300. Topics, discussed from an advanced viewpoint, include mathematical induction, the completeness axiom, composition of functions, sequences, a vector approach to geometry, axioms of the Hilbert type. Prerequisite: Math. 300 or consent of the instructor.
- 302. Teachers Course III. 4 hours.** Continues Math. 301. Topics, discussed from an advanced viewpoint, include arithmetic and geometric progressions, continued sums and products, difference sequences, pigeon-hole principle, limits, continuity, exponential functions, logarithmic functions, circular functions, combinations and permutations. Prerequisite: Math. 301 or consent of the instructor.
- 303. Advanced Euclidean Geometry I. 4 hours.** Geometry from Euclid to the present, equivalents of Euclid's fifth postulate, noneuclidean geometries, finite and projective geometries, invariants of configurations under transformation. Prerequisite: Math. 133.
- 304. Advanced Euclidean Geometry II. 4 hours.** The parallel postulate, similarity, area perpendicularity, circles and spheres, constructions with ruler and compass. Prerequisite: Math. 303.
- 305. Advanced Euclidean Geometry III. 4 hours.** Ruler and compass constructions, proportionality, length and area, solid mensuration, hyperbolic geometry. Prerequisite: Math. 304.
- \*306. Seminar in Mathematics for Teachers. 4 hours.** May be repeated for a total of 12 hours. Advanced topics and special problems in teaching of precollege mathematics. Prerequisite: Math. 302.
- 307. Theory of Sets and the Real Number System. 5 hours.** The elementary set theory and the development of the integers, the rational numbers, and the real numbers. Prerequisite: Math. 133.
- 310. Higher Analysis I. 4 hours.** The number system, functions, sequences and limits, continuity and differentiability, integration, the elementary transcendental

\*Approval pending.

functions, limits and continuity, properties of differentiable functions. Individual projects are assigned. Prerequisite: Math. 133.

311. **Higher Analysis II. 4 hours.** Vectors and curves, functions of several variables, limits and continuity, differentiable functions, transformations and implicit functions, extreme values, multiple integrals, line and surface integrals. Prerequisite: Math. 310.
312. **Higher Analysis III. 4 hours.** Infinite series, sequences and series of functions, uniform convergence, Taylor series, improper integrals, integral representation of functions. Fourier series. Prerequisite: Math. 311.
321. **Elementary Differential Equations II. 4 hours.** Systems of linear first order equations. Boundary value problems for second order linear equations, and introduction to partial differential equations. Nonlinear problems described by one or two differential equations of first order. Prerequisite: Math. 220.
322. **Elementary Partial Differential Equations I. 4 hours.** Second order linear partial differential equations and their initial value and boundary value problems. Separations of variables and Green's formula considerations. Eigenfunction expansions for homogeneous and inhomogeneous heat equation in finite domains. Sturm-Liouville problem. Fourier series. Prerequisites: Math. 310 and 321.
323. **Elementary Partial Differential Equations II. 4 hours.** The potential equation and the wave equation in finite domains. Semi-infinite domains. Fourier integrals. Cylindrical and spherical harmonics. Fourier-Bessel and Legendre-Bessel expansions. Prerequisite: Math. 322.
330. **Complex Variables for Engineering and Applied Mathematics I. 4 hours.** Credit is not given for Math. 330 if the student has credit in 332 or 333. Complex numbers and their geometrical representation, point sets of complex numbers, analytic functions, elementary functions, integration, power series, Taylor and Laurent expansions, the calculus of residues. Prerequisite: Math. 310.
331. **Complex Variables for Engineering and Applied Mathematics II. 4 hours.** Credit is not given for Math. 331 if the student has credit in 332 or 333. Properties of mappings, the calculus of residues and loop integration, conformal representation, application of analytic functions to the theory of flows, potentials and related fields. Prerequisite: Math. 330.
332. **Complex Variables I. 4 hours.** Credit is not given for Math. 332 if the student has credit in 330 or 331. Power series in one variable, holomorphic functions, Cauchy's integral, Taylor and Laurent expansions. Prerequisite: Math. 312.
333. **Complex Variables II. 4 hours.** Credit is not given for Math. 333 if the student has credit in 330 or 331. Analytic functions of several complex variables, harmonic functions, convergence of sequences of holomorphic functions, infinite products, normal families, holomorphic transformations, holomorphic systems of differential equations. Prerequisite: Math. 332.
340. **Modern Higher Algebra I. 4 hours.** Sets and real numbers, groups, rings. Prerequisite: Math. 133.
341. **Modern Higher Algebra II. 4 hours.** Euclidean and polynomial rings, vector spaces, linear transformations, and matrices. Prerequisite: Math. 340.
342. **Modern Higher Algebra III. 4 hours.** Dual spaces, inner product spaces, modules, canonical forms of matrices, quadratic forms. Prerequisite: Math. 341.

- 343. Formal Logic I. 4 hours.** Same as Phil. 343. Propositional logic, logic of quantifiers, and identity and completeness. Prerequisite: Consent of the instructor; none for mathematics majors.
- 344. Formal Logic II. 4 hours.** Same as Phil. 344. Continues Math. 343. Mathematical analysis of decidability and computability. Arithmetization of syntax. Incompleteness and undefinability theorems. Introduction to axiomatic set theory. Individual conferences on assigned papers are required. Prerequisite: Math. 343.
- 348. Linear Transformations and Matrices. 5 hours.** Matrix algebra, determinants, inverses of matrices, rank and equivalence, linear independence, vector spaces and linear transformation, unitary and orthogonal transformations, characteristic equation of a matrix. Prerequisite: Math. 133.
- 350. Introduction to Higher Geometry I. 4 hours.** Projective properties in the euclidean plane, extending the euclidean plane, the projective plane, axioms for the projective plane, conics, introduction of coordinates. Prerequisite: Math. 342.
- 351. Introduction to Higher Geometry II. 4 hours.** Topics in geometry, projective planes, higher dimensional projective geometries, model as subspaces of a vector space, coordinization. Prerequisite: Math. 350.
- 352. Introduction to Higher Geometry III. 4 hours.** Introduction to differential geometry, curves, surfaces, manifolds imbedded in euclidean space, Riemannian geometry, first and second fundamental forms of imbedded surfaces. Prerequisite: Math. 310 and 351.
- 355. Introduction to Topology I. 4 hours.** Set theory, topological spaces, metric spaces, continuous maps, connectedness, compactness, separation axioms, completely separable spaces, mappings into Hilbert spaces. Prerequisite: Math. 310.
- 356. Introduction to Topology II. 4 hours.** Locally connected spaces, arcs and arc-wise connectivity, Cantor sets, Hahn-Mazurkiewicz theorem, elements of homotopy theory. Prerequisites: Math. 340 and 355.
- 357. Introduction to Topology III. 4 hours.** Vector spaces, polytopes, homology theory, Euler-Poincare formula, simplicial mappings, Brouwer degree and Brouwer fixed-point theorem. Prerequisite: Math. 356.
- 360. Elementary Theory of Numbers I. 4 hours.** The basic concepts of the theory of numbers: divisibility, prime numbers congruences, quadratic reciprocity law. Prerequisite: Math. 133 or approval of the department.
- 361. Theory of Numbers II. 4 hours.** Functions of number theory, recurrence functions, diophantine equations, quadratic forms, Farey sequences and rational approximations. Prerequisite: Math. 360 or consent of the instructor.
- 362. Theory of Numbers III. 4 hours.** Continued fractions, distribution of primes, algebraic numbers, polynomials, partitions, density of sequences of integers. Prerequisite: Math. 361 or consent of the instructor.
- 370. Introduction to Probability and Statistics. 4 hours.** Probability models, univariate and multivariate distributions, random variables. Prerequisite: Math. 133.
- 371. Statistics I. 4 hours.** Statistical problems and procedures, estimation, testing hypotheses, distribution theory. Prerequisite: Math. 370.



- 372. Statistics II. 4 hours.** One-sample problems, comparison, linear models, and analysis of variance. Prerequisite: Math. 371.
- 375. Probability. 4 hours.** Law of large numbers, central limit theorem, recurrent events, random walks, Markov chains. Prerequisite: Math. 370.
- 377. Finite Differences I. 4 hours.** Difference formulas, finite integration, summation of series, Bernoulli and Euler polynomials, interpolation. Prerequisite: Math. 133.
- 378. Finite Differences II. 4 hours.** Approximate integration, beta and gamma functions, difference equations. Prerequisite: Math. 377.
- 381. Vector and Tensor Analysis I. 4 hours.** Algebra of vectors, vector differential calculus, differential geometry, Stokes' theorem, divergence theorem, application to electricity, mechanics, hydrodynamics, and elasticity. Prerequisite: Math. 311.
- 382. Vector and Tensor Analysis II. 4 hours.** Algebra of vectors, vector and scalar multiplication, tensor covariance, contravariance, geodesics, covariant differentiation, curvature tensor and interpretation, the Ricci and Einstein tensor, Riemannian curvature, flat space, Cartesian tensor, physical components of tensors, dynamics of a particle and of a rigid body, general dynamical systems. Prerequisite: Math. 311 or 381.
- 385. Laplace Transforms. 3 hours.** The Laplace transform and its inverse; properties of the transform; linear differential equations (ordinary and partial); linear difference equations, gamma, error, and Bessel functions; asymptotic series; nonelementary integrals; integral equations; Hankel transforms. Prerequisite: Math. 330.
- 387. Numerical Analysis I. 4 hours.** Math. 387 and 388 together provide a comprehensive introduction to linear numerical analysis. Computational methods and error analysis for matrix inversion, eigenvalues and eigenvectors, and linear approximations. Prerequisites: Math. 133 and 194 or 195.
- 388. Numerical Analysis II. 4 hours.** Continues Math. 387. Prerequisite: Math. 387.
- 389. Numerical Analysis III. 4 hours.** Numerical integration and differentiation. Quadrature in  $n$  dimensions. Numerical integration of ordinary differential equations. Prerequisite: Math. 388.
- 391. Boolean Algebra and Switching Theory. 4 hours.** Sets, relations, function, equivalence relations, abstract Boolean algebra. Applications of Boolean algebra. Minimization of Boolean functions. Representation of finite Boolean algebras. Prerequisite: Math. 310 or 340.
- 392. Introduction to Automata Theory. 4 hours.** Boolean rings and lattices as Boolean algebras. Synchronous sequential circuits. Mealy and Moore models of automata. Regular sets. Prerequisite: Math. 391.
- 393. Automata and Languages. 4 hours.** Types of automata and their events. The semigroup of an automation. Basic decomposition theory. Introduction to formal languages. Grammars of types 0, 1, 2, 3. Properties of context-free languages. Prerequisite: Math. 392.
- 395. Systems Programming I. 3 hours.** The logical organization of a modern digital computer. Assembly language programming for such a machine. Prerequisite: Math. 194 or 195.

- 397. Systems Programming III. 4 hours.** Problems of planning and implementing an operating system for a modern digital computer so as to utilize its power to the fullest possible extent. Prerequisite: Math. 281.
- 399. Honors in Mathematics. 4 hours.** May be repeated for credit. Seminars on special topics and advanced problems to permit students majoring in mathematics to do independent study under the guidance of senior members of the staff. Prerequisites: Math. 312 and 342 or consent of the instructor.

## **PHILOSOPHY**

### **Professors**

George T. Dickie, Acting Chairman of the Department; Ruth B. Marcus, Daniel J. Morris, William W. Tait, Paul Ziff.

### **Associate Professors**

Arnold B. Levison, Brian Skyrms, Irving Thalberg.

### **Assistant Professors**

Sandra L. Bartky, David C. Blumenfeld, Rudolf Grewe, Terence D. Parsons.

The Department of Philosophy offers work leading to the M.A. and the Ph.D.

## **Admission Requirements**

Graduate students in philosophy must have a grade-point average of at least 4.00 for the last two years of completed undergraduate work. Students whose average is below 4.00 but above 3.75 will be considered for admission on an individual basis. An undergraduate major in philosophy is not a requirement for admission.

Applicants should have had courses in modern formal logic, ethics, history of philosophy, and theory of knowledge or philosophy of science. Students admitted with deficiencies are required to take one or more of the following courses: Philosophy 211, 301, 302, 304, 306, 330, 332.

All students are required to take a qualifying examination during their first year of graduate study. This short written examination tests a student's ability to deal with philosophical problems.

## **Degree Requirements**

*Master of Arts.* A candidate must choose at least one course in each of the following areas: history of philosophy; the theory of knowledge, including logic, philosophy of science, and philosophy of language; and in the theory of value, including ethics and aesthetics. The department also requires the student to:

Complete a unified program of 48 quarter hours of graduate study under the direction of an adviser.

Pass the first-year qualifying examination at the master's level.

*Doctor of Philosophy.* A full program consists of 16 hours of credit work each quarter for a total of 144 credit hours. A student must complete all re-

quirements within seven years after entering the program; normally, a student carrying a full program would be expected to complete the requirements in fewer than five years. Exceptions will be permitted only under conditions of unusual hardship.

Students progress toward the Ph. D. in three stages:

(1) During the first year of study, take the first-year qualifying examination for advancement toward the doctoral program.

(2) During the second year, take the comprehensive written examination. This examination consists of four parts: history of philosophy, logic and philosophy of science, metaphysics and epistemology, and value theory.

(3) After a candidate has passed the comprehensive examination and has chosen the subject of his dissertation, an appointed doctoral committee will administer a preliminary oral examination to determine whether his research project is feasible and is sufficiently original and serious. The committee will then recommend formal advancement to candidacy for the Ph.D., and a member of the committee will be named to supervise the writing of the dissertation. Upon completion of his dissertation the candidate will be required to defend it in a final oral examination.

The language requirement for each student will be determined by a departmental committee of graduate faculty. The basis for the determination will be a consideration of the area in which the student intends to specialize. In no case will proficiency in more than two languages be required. In those areas where the primary sources are in English, a foreign language will not be required.

A detailed statement of the special departmental requirements for graduate students can be obtained from the Department of Philosophy, 1803 University Hall.

## Courses for Graduate Students

- 401. **Seminar: Topics in Ancient Philosophy. 6 hours.** May be repeated once for credit with consent of the instructor. Specialized study in the area of ancient philosophy. Prerequisite: Graduate standing.
- 403. **Seminar in Medieval Philosophy. 6 hours.** Study of selected major philosophical works of the Middle Ages. Prerequisite: Graduate standing.
- 405. **Seminar: Topics in Modern Philosophy. 6 hours.** May be repeated once for credit with the consent of the instructor. Intensive analysis of the work of one important philosopher or philosophical movement between 1600 and 1900. Prerequisite: Graduate standing.
- 407. **Seminar: Topics in Contemporary Philosophy. 6 hours.** May be repeated once for credit with the consent of the instructor. Intensive analysis of the the work of one important philosopher or philosophical movement of the twentieth century. Prerequisite: Graduate standing.
- 411. **Seminar in Recent Ethical Theory. 6 hours.** May be repeated once for credit with the consent of the instructor. Prerequisite: Graduate standing.
- 413. **Seminar in Logical Theory. 6 hours.** May be repeated once for credit with the consent of the instructor. Prerequisites: Graduate standing and Phil. 343 or consent of the instructor.



- 415. Seminar in Metaphysics, 6 hours.** May be repeated once for credit with the consent of the instructor. Prerequisite: Graduate standing.
- 417. Seminar in the Philosophy of Science. 6 hours.** Prerequisite: Graduate standing.
- 419. Seminar in the Philosophy of Language. 6 hours.** Prerequisite: Graduate standing.
- 421. Seminar in the Theory of Knowledge. 6 hours.** Selected topics in the contemporary theory of knowledge. Prerequisite: Graduate standing.
- 423. Seminar in Aesthetics. 6 hours.** Prerequisite: Graduate standing.
- 479. Seminar: Theoretical, Historical, and Philosophical Issues in Psychology. 2 hours.** Same as Hist. 469 and Psch. 479. May be repeated. Systematic review of special topics, with emphasis on current approaches and interpretations. Prerequisite: Consent of the instructor.
- 483. Independent Study. 2 to 8 hours.** Topics and plan of study must be approved by the candidate's adviser and by the staff member who directs the work.
- 499. Thesis Research. 0 to 16 hours.**

### **Courses for Graduate and Advanced Undergraduate Students**

- 301. Plato. 4 hours.** Selected dialogues.
- 302. Aristotle. 4 hours.** Reading and discussion of some of the basic works.
- 304. Seventeenth Century Rationalism. 4 hours.** Selected readings and discussion from the works of Descartes, Spinoza, Leibniz.
- 306. British Empiricism. 4 hours.** Selected readings from the works of such philosophers as Locke, Berkeley, and Hume.
- 308. Kant. 4 hours.** Kant's philosophy, with emphasis on the *Critique of Pure Reason*.
- 310. Nineteenth Century and Early Twentieth Century Thought. 4 hours.** May be repeated for credit with the approval of the department. Studies of selections from the writings of Hegel, Schelling, Fichte, Schopenhauer, Marx and Engels, J. S. Mill, Nietzsche, McTaggart, Green, Bradley, Peirce, Perry, and others. Prerequisite: Two courses in philosophy, one of which must be a 200-level course.
- 311. Inductive Logic. 4 hours.** Traditional and contemporary problems of induction. Inductive logic and the theory of probability.
- 312. Recent and Contemporary Philosophy: Analysis and Logical Empiricism. 4 hours.** Developments in recent philosophy which have their roots in the study of logic and language, such as logical atomism, positivism, and analytical philosophy.
- 314. Recent and Contemporary Philosophy: Phenomenology and Existential Philosophy. 4 hours.** A study of important contributions to the phenomenological movement. Selected readings from Husserl, Heidegger, Jaspers, Sartre, Merleau-Ponty, and others. Prerequisite: Two courses in philosophy.
- 322. Problems in the Foundations of Logic and Mathematics. 4 hours.** Survey of selected problems. Prerequisite: Phil. 211 or equivalent.

- 330. Theory of Knowledge. 4 hours.** The grounds of belief; the nature of truth; evidence and proof; other related epistemological problems.
- 332. Ethics and Value Theory. 4 hours.** The nature of moral judgements and moral reasoning; ethics as a normative discipline; definitions of "value"; ethical judgements as a kind of value judgement.
- 334. Aesthetics. 4 hours.** The aesthetic object. Form, representation, and meaning in art. Art and knowledge.
- 336. Metaphysics. 4 hours.** Systematic analysis of selected metaphysical concepts, such as existence, substance and attribute, universals and particulars, change, identity, space and time, and the individual. Recent as well as traditional points of view are considered.
- 338. Philosophical Analysis of the Concept of Mind. 4 hours.** Presuppositions and logical interconnections involved in the use of such terms as "mind," "thoughts," "action," and "will."
- 340. Philosophy of Language. 4 hours.** Philosophical and logical problems concerned with the nature of meaning and the structure of language. Individual conferences on assigned papers are required. Prerequisite: Two courses in philosophy, one of which must be a 200-level course, but cannot be 211. In addition 211 or 343 or some demonstration of familiarity with the techniques of symbolic logic is required. In the last case, consent of the instructor is required.
- 343. Formal Logic I. 4 hours.** Same as Math. 343. Propositional logic, logic of quantifiers, and identity and completeness. Individual conferences on assigned papers are required. Prerequisite: Consent of the instructor; none for mathematics majors.
- 344. Formal Logic II. 4 hours.** Same as Math. 344. Continues Phil. 343. Mathematical analysis of decidability and computability. Arithmetization of syntax. Incompleteness and undefinability theorems. Introduction to axiomatic set theory. Individual conferences on assigned papers are required. Prerequisite: Phil. 343.
- 345. Philosophical Problems of the Sciences. 4 hours.** May be repeated for credit with the permission of the department. Reading and discussion of selected works on the aims and methods of science, the status of scientific theories, natural laws and theoretical entities, and the nature of explanation.
- 351. Problems in the Philosophy of Mathematics. 4 hours.** Intensive study of a particular problem or nexus of problems in the philosophy of mathematics. Prerequisite: Phil. 343 or consent of the instructor; none for mathematics majors.
- 399. Independent Study. 1 to 8 hours.** Independent study, under the supervision of a staff member, of a topic not covered in the regular curriculum. The course is offered at the request of the student and only at the discretion of the staff members concerned. Prerequisite: Approval of the department.

## PHYSICS

### Professors

Swaminatha Sundaram, Head of the Department; Seymour Bernstein, Arnold R. Bodmer, Edward B. McNeil, R. Curtis Retherford, Herman B. Weissman, Lester Winsberg.

## **Associate Professors**

Alan Edelstein, James W. Garland, Gloria Hoff, William J. Otting, John N. Pappademos, David S. Schreiber, Ram R. Sharma.

## **Assistant Professors**

Larry L. Abels, Stanley Aks, Richard A. Carhart, Howard S. Goldberg, Stephan J. Krieger, Seymour Margulies, Donald W. McLeod, Donald M. Rote, Julius Solomon, David J. Vezzetti.

The Department of Physics offers graduate work leading to the degree of Master of Science in the following areas of specialization:

Theoretical physics, including nuclear structure and hypernuclei, strong and weak interactions of elementary particles, quantum field theory, statistical mechanics, electromagnetic theory, superconductivity.

Experimental high energy physics, closely related to the theoretical particle physics. The facilities of Argonne National Laboratory are available in addition to those on campus.

Theoretical and experimental atomic and molecular physics—ultraviolet, visible, and infrared spectra, including electronic transitions.

Theoretical and experimental solid state physics—phonon scattering, superconductivity, dielectrics, and low temperature studies.

## **Admission Requirements**

In addition to fulfilling the general requirements of the Graduate College, an applicant must have had 30 quarter hours of courses in physics (excluding courses in general physics and including Physics 301, 302, 321, and 341 or their equivalents) and a grade-point average of at least 3.75 ( $A=5.00$ ) for the last 90 quarter hours of undergraduate work. Under exceptional circumstances students with a somewhat lower average may be admitted. A student with an average of less than 3.50 will not be admitted under any condition. Students who lack some of the prerequisite courses (Physics 301, 302, 321, 341) may be considered for admission but will be required to take these courses during their first year without receiving graduate credit.

## **Degree Requirements**

Forty-eight quarter hours of satisfactory course work are required, with at least 24 hours in physics. Twenty of the 48 must be in 400-level courses with at least 16 in physics, not including Physics 499, Thesis Research.

Ordinarily, preparation of a thesis is not required, but if the student so elects, a maximum of 12 quarter hours of credit may be allowed.

## **Courses for Graduate Students**

**401. Electrodynamics I. 4 hours.** Maxwell's equations; static and time-dependent fields; boundary value problems; wave propagation. Prerequisite: Phys. 303 or approval of the department.



- 402. Electrodynamics II. 4 hours.** Classical theory of radiation; radiation reaction; special relativity; covariant formulation of electrodynamics. Prerequisite: Phys. 401 or approval of the department.
- 403. Electrodynamics III. 4 hours.** Lagrangian formulation of electrodynamics; action principles; special topics in electromagnetic theory. Prerequisite: Phys. 402 or approval of the department.
- 411. Quantum Mechanics I. 4 hours.** Wave functions, uncertainty principle and Schrodinger equation, one and three-dimensional one-particle problems, approximate methods. Prerequisite: Phys. 322 or approval of the department.
- 412. Quantum Mechanics II. 4 hours.** Operators and Hilbert space formulation, symmetries and conservation laws, angular momentum and rotations, coupling of angular momenta, spherical tensors, scattering, phase shifts, Born series, scattering in Coulomb field, inelastic scattering. Prerequisite: Phys. 411 or approval of the department.
- 413. Quantum Mechanics III. 4 hours.** Introduction to formal theory of scattering. S-matrix, time-dependent and independent formulations of scattering, introduction to relativistic quantum mechanics, Klein-Gordon and Dirac equations, introduction to the quantum field theory, electromagnetic transitions, particles and antiparticles. Prerequisite: Phys. 412 or approval of the department.
- 421. Atomic and Molecular Physics I. 4 hours.** Hydrogen atom and one-electron systems, helium atom, self-consistent field theory, alkali spectra, vector model, Zeeman and Stark effects, fine and hyperfine structure, collisions, ionization. Prerequisite: Phys. 322 or approval of the department.
- 422. Atomic and Molecular Physics II. 4 hours.** Rotation and vibrational energies of diatomic molecules, potential curves, electronic transitions and transition moments, intensities, thermodynamic properties, applications. Prerequisites: Phys. 322 or approval of the department.
- 423. Atomic and Molecular Physics III. 4 hours.** Structure and symmetry of molecules, vibrational and rotational spectra, experimental infrared and Raman spectra, chemical bonding, molecular interactions, molecular collisions, intermolecular potentials, relaxation phenomena. Prerequisite: Phys. 322 or approval of the department.
- 425. Solid State Physics I. 4 hours.** Crystal structure, X-ray methods, crystal forces, lattice theory, vibrations, heat conductivity. Prerequisite: Phys. 323 or approval of the department.
- 426. Solid State Physics II. 4 hours.** Electric and magnetic properties of solids, free-electron model of metals, quantum statistics, band theory, order-disorder theory. Prerequisite: Phys. 425 or approval of the department.
- 427. Solid State Physics III. 4 hours.** Semiconductors, ferromagnetism and antiferromagnetism, superconductivity, lattice vacancies, color centers, excitons, luminescence. Prerequisite: Phys. 426 or approval of the department.
- 431. Elementary Particle and Nuclear Physics I. 4 hours.** Two-nucleon system: properties of the deuteron, nucleon-nucleon scattering, nuclear forces. Properties of pions and pion-nucleon scattering, other nonstrange mesons; introduction to strange particles and higher symmetries. Prerequisite: Phys. 412 or approval of the department.

- 432. Elementary Particle and Nuclear Physics II. 4 hours.** General properties of nuclei; sizes, binding energies, stability, saturation. Introduction to nuclear models and structure. Beta decay and weak interactions. Prerequisite: Phys. 431 or approval of the department.
- 433. Nuclear Physics I. 4 hours.** Review of two-nucleon system and nuclear forces, nuclear models and nuclear spectroscopy. Individual-particle model, collective model, particle-hole excitations, pairing, Electromagnetic interactions. Prerequisites: Phys. 413 and 432 or approval of the department.
- 434. Nuclear Physics II. 4 hours.** Nuclear reactions: compound nucleus, optical model, direct reactions. Nuclear forces and nuclear structure; light nuclei, nuclear many-body problem; nucleon-nucleus scattering at high energies. Interactions of particles other than nucleons with nuclei. Prerequisite: Phys. 433 or approval of the department.
- 435. Elementary Particle Physics I. 4 hours.** Fields and invariance principles, relativistic kinematics and scattering, strong and electromagnetic interactions of nonstrange particles. Pions and nucleons, resonances, introduction to dispersion relations, one-particle exchanges, electromagnetic form factors. Prerequisites: Phys. 413 and 432 or approval of the department.
- 436. Elementary Particles II. 4 hours.** Strong interactions of strange particles; higher symmetries; weak interactions of nonstrange and of strange particles. Prerequisite: Phys. 435 or approval of the department.
- 441. Classical Mechanics. 4 hours.** Variational principles; Lagrange's and Hamilton's equations; Hamilton-Jacobi theory; rigid body motion; small oscillations; continuous systems and fields. Prerequisite: Phys. 343 or approval of the department.
- \*445. Introduction to General Relativity. 4 hours.** Deficiencies of Newtonian gravitational theory, principle of equivalence, the metric field and geodesics, tensor analysis and differential geometry, Einstein's equations and the action principle, the energy-momentum pseudotensor, gravitational fields and waves. Prerequisites: Phys. 402 and 441 or approval of the department.
- 461. Statistical Mechanics. 4 hours.** Classical and quantum-statistical mechanics; Maxwell, Bose, Fermi statistics; ensemble theory; imperfect gas; selected applications. Prerequisite: Phys. 361 or approval of the department.
- 481. Mathematical Methods of Physics I. 4 hours.** Introduction to the linear methods of mathematical physics from the modern point of view. Mathematical foundations of quantum theory; classical problems of differential equations. Prerequisite: Approval of the department.
- 482. Mathematical Methods of Physics II. 4 hours.** Applications of linear analysis to ordinary and partial differential equations and integral equations. Properties of classical special functions and generalized functions. Prerequisite: Phys. 481 or approval of the department.
- \*486. Problems in Teaching Physics. 4 hours.** The learning-teaching process in physics. Presentation methods of types of physics courses given in high schools and colleges. Individual projects will be assigned. Prerequisite: Approval of the department.
- 497. Individual Study. 2 to 4 hours.** Special topics. Outside reading and term paper will be assigned by special arrangement with the department and faculty. Prerequisite: Approval of the department.

498. **Special Topics in Modern Physics. 4 hours.** Students may enroll in more than one section of this course concurrently. Topics of current interest are given under this number. Subjects are announced. Prerequisites: Phys. 411 and 412 or consent of the instructor.
499. **Thesis Research. 0 to 16 hours.** Prerequisite: Approval of the department.

## **Courses for Graduate and Advanced Undergraduate Students**

301. **Electricity and Magnetism I. 4 hours, lecture and laboratory; 3 hours, lecture only.** Credit is not given to graduate physics majors and engineering majors. Applications of and problems in circuit theorems, electric fields, capacitance, energy and forces associated with these fields in free space and in matter. Prerequisites: Credit or registration in Phys. 114 and Math. 321.
302. **Electricity and Magnetism II. 4 hours, lecture and laboratory; 3 hours, lecture only.** Credit is not given to graduate physics majors and engineering majors. Applications of and problems in circuit theorems, magnetic fields, inductance, energy and forces associated with these fields in free space and matter, electromagnetic induction, Maxwell's equations. Prerequisite: Phys. 301.
303. **Electricity and Magnetism III. 4 hours, lecture and laboratory; 3 hours, lecture only.** Effects associated with changing fields and currents, transients, coupled circuits, filters, transmission lines, electromagnetic waves, circuit theorems in transient and steady state analysis. Prerequisite: Phys. 302.
304. **Electronics I. 4 hours.** Theory of electronic devices, linear and nonlinear analysis, applications of vacuum and semiconductor devices to circuits, amplifiers, biasing, feedback, oscillators, and special circuits. Prerequisite: Phys. 301. Phys. 302 and 303 are recommended.
305. **Electronics II. 4 hours.** Pulse-shaping networks, logic circuits, control circuits, distributed amplifiers, special problems of transducers, special signal-to-noise techniques. Prerequisite: Phys. 304.
321. **Atomic Physics. 4 hours.** The properties of free electrons and ions, photons and their interaction with matter, atomic spectra and structure, introduction to quantum mechanics. Individual projects are required. Prerequisite: Phys. 114. Credit or registration in Math. 321 is recommended.
322. **Atomic and Molecular Physics. 4 hours.** Diatomic molecules: vibrational spectra, potential energy curves, chemical bonding, band structure. Polyatomic molecules; Raman, infrared, rotational, and microwave spectra, force fields and chemical bonding. Individual projects are required. Prerequisite: Phys. 321.
323. **Elementary Solid State Physics. 4 hours.** Crystal structure, thermal and dielectric properties of solids, free electron model of metals, band theory, semiconductor physics, dislocations and strength of solids. Individual projects are required. Prerequisite: Phys. 322.
331. **Nuclear Physics. 4 hours.** Natural and artificial radioactivity, equipment for studying and producing high-energy particles, nuclear disintegrations, interaction of nuclear particles with each other and with matter, cosmic rays, mesons, recent developments in high-energy physics. Individual projects are required. Prerequisite: Phys. 321.



- 341. Theoretical Mechanics I. 4 hours.** Credit is not given to graduate physics majors. Motion of a particle in one, two, and three dimensions, Kepler's laws and planetary motion, scattering of particles, conversion between laboratory and center of mass coordinate systems, conservation laws, motion of a rigid body in two dimensions. Individual projects are required. Prerequisites: Phys. 301 and Math. 321.
- 342. Theoretical Mechanics II. 4 hours.** Statics of extended systems, moving coordinate frames, fictitious forces and conservation laws, special theory of relativity, mechanics of continuous media. Individual projects are required. Prerequisite: Phys. 341.
- 343. Theoretical Mechanics III. 4 hours.** Rigid-body motion in three dimensions, motion in gravitational fields, generalized coordinates and Lagrange and Hamilton equations, equations of constraint, small-vibration theory. Individual projects are required. Prerequisite: Phys. 342.
- 361. Thermal and Statistical Physics I. 4 hours.** Systems of particles, systems in equilibrium, laws of thermodynamics, thermal properties, application to simple physical and chemical systems, phase transitions, introduction to statistical mechanics. Individual projects are required. Prerequisite: Phys. 321.
- 362. Thermal and Statistical Physics II. 4 hours.** Quantum statistics of ideal gases, magnetism and low temperatures, kinetic theory of transport processes, irreversible processes and fluctuations. Individual projects are required. Prerequisite: Phys. 361.
- 371. Light (Wave Optics). 4 hours, lectures and laboratory; 2 hours, lectures only.** Wave propagation and Maxwell's equations, interference and interferometers, gratings, circular aperture, echelon, resolving power. Prerequisite: Phys. 114 and credit or registration in Math. 220.
- 372. Light (Modern Optics) I. 4 hours, lecture and laboratory; 2 hours, lecture only.** Crystals, polarized light, optics of metals, quantum theory of radiation, transition probability and oscillator strength, dispersion and scattering theory. Lecture and laboratory. Prerequisite: Phys. 371.
- 373. Light (Modern Optics) II. 4 hours.** Gaussian optics and general laws, special optical systems and applications. Image formation, finite image-error theory, spot diagrams. Necessary mathematical tools for Fourier analysis and transfer functions. Prerequisite: Phys. 372.
- 381. Modern Experimental Physics I. 4 hours, lecture and laboratory; 1 hour, lecture only.** Techniques and experiments in the physics of atoms, atomic nuclei, molecules, the solid state, and other areas of modern physical research. Prerequisites: Phys. 304 and 331.
- 382. Modern Experimental Physics II. 4 hours.** Continues Phys. 381. Lecture and Laboratory. Prerequisite: Phys. 381.

## PSYCHOLOGY

### Professors

Harry S. Upshaw, Acting Head; Philip Ash, Rosalind D. Cartwright, Isadore E. Farber, Harold Klehr, Eli A. Lipman.

### **Associate Professors**

William H. Bogartz (Visiting), Alvin G. Burstein, John D. Davis, Roger L. Dominowski, Allen H. Howard, Vivian C. Lipman, Susan M. Markle, Nan E. McGehee, Evalyn F. Segal, Robert S. Wyer.

### **Assistant Professors**

Philip E. Freedman, Howard Gadlin, Alexander J. Rosen, Herbert H. Stenson.

Graduate work leading to the degree of Master of Arts is offered in the following areas of specialization: general experimental psychology, applied psychology (industrial and clinical counseling), and personality-social-developmental psychology.

### **Admission Requirements**

Departmental requirements include: a grade-point average of 4.00 for the last two years of undergraduate study (students whose average is below 4.00 may be considered on the basis of individual merit); the equivalent of 24 quarter hours in psychology, including statistics and a laboratory course in experimental psychology; one year of college mathematics and one year of laboratory courses in physical and/or biological science; satisfactory standing on the aptitude (Verbal, Quantitative) tests of the Graduate Record Examination.

It may not be possible to accept all applicants who meet the foregoing minimal requirements. Preference will be given to candidates particularly well qualified in mathematics and the natural sciences. In special cases, candidates who do not fulfill all course requirements may be admitted provisionally, pending satisfactory completion of these requirements without graduate credit.

### **Degree Requirements**

Candidates must complete satisfactorily 48 quarter hours of graduate-level course work (including research) and present an acceptable thesis. At least 16 quarter hours must be in 400-level courses.

All candidates must complete at least 16 quarter hours in general psychology (quantitative, experimental, theoretical), 12 hours in their area of specialization, and 4 hours of thesis research. The remaining 16 hours may be taken in any area of psychology or in other departments.

### **Courses for Graduate Students**

**Note:** The prerequisites stated apply to graduate majors in psychology. Students minoring in psychology or majoring in related fields may, with the consent of the instructors, enroll in certain courses without having met all prerequisites.

- 410. Experimental Approaches to Personality. 4 hours.** Analysis of empirical and theoretical advances in experimental research in personality. Emphasis on the interaction of experimental factors in learning, motivation, and cognition with individual differences variables. Prerequisite: Consent of the instructor.

411. **Small Groups: Structure and Process. 4 hours.** Same as Soc. 411. Systematic survey of research and theory dealing with social interaction and social relationships in small groups; primary groups as agents of social influence and social control. Prerequisite: Consent of the instructor.
420. **Advanced Developmental Psychology. 4 hours.** Theory and research on psychological development through adolescence; physical, mental, and social growth. Prerequisites: Psch. 220 or the equivalent and consent of the instructor.
425. **Practicum in Developmental Psychology. 2 hours.** May be repeated. Supervised practice in the observation and assessment of behavior development in naturalistic settings, including preschool, grade school, and special treatment units. Normal and exceptional children and adolescents. Prerequisites: Psch. 420 or the equivalent and consent of the instructor.
429. **Seminar in Developmental Psychology. 2 hours.** May be repeated. Systematic review of special topics, with emphasis on current research. Prerequisites: Psch. 420 or the equivalent and consent of the instructor.
430. **Psychological Counseling. 4 hours.** Basic principles, practices, and theories of counseling. Prerequisite: Consent of the instructor.
434. **Practicum in Business and Industrial Psychology. 2 to 4 hours.** May be repeated. Supervised practicum in a business or industrial setting. Personnel selection, evaluation, training, organization, morale, human factors, advertising, and consumer psychology. Prerequisite: Psch. 332 or consent of the instructor.
435. **Practicum in Psychological Counseling. 2 hours.** May be repeated. Supervised practice in a counseling or clinical setting. Application of basic principles; special emphasis on the problems of the culturally disadvantaged. Prerequisites: Psch. 430 and consent of the instructor.
438. **Seminar in Business and Industrial Psychology. 2 hours.** May be repeated. Systematic review of special topics, with emphasis on current research and theoretical developments. Prerequisite: Consent of the instructor.
439. **Seminar in Psychological Counseling. 2 hours.** May be repeated. Systematic review of special topics, with emphasis on current research. Prerequisites: Psch. 430 and consent of the instructor.
441. **Survey Research Methods. 4 hours.** Same as Soc. 404. Methods of sampling human populations; interviewing techniques; techniques of analyzing survey data; the uses and limits of sample surveys in testing hypotheses; supervised participation in survey research. Prerequisite: Psch. 343 or the equivalent.
443. **Advanced Statistics II. 4 hours.** The Chi-square and F-distributions, analysis of variance, individual comparisons, regression, and correlation analysis. Prerequisite: Psch. 343 or the equivalent.
444. **Design of Experiments. 4 hours.** Advanced experimental designs in behavioral research. Testing of hypotheses concerning contrasts in means in single-factor and multifactor, completely randomized, and repeated measurement designs. Prerequisite: Psch. 443 or the equivalent.
445. **Correlational Methods. 4 hours.** Multiple, partial, curvilinear, biserial, and tetrachoric correlation; discriminant analysis; correlation ratio; sampling theory applied to correlation. Prerequisite: Psch. 443 or the equivalent.
447. **Psychological Measurement. 4 hours.** Scaling theory and methodology, with



emphasis on measurement in psychophysics, differential psychology, and social psychology. Prerequisites: Psch. 343 and 315 or 356 or the equivalents.

- 449. Seminar in Quantitative Methods in Psychology. 2 hours.** May be repeated. Systematic review of special topics, with emphasis on current developments and applications. Prerequisite: Consent of the instructor.
- 451. Behavior Modification. 4 hours.** Critical analysis of principles, techniques, and research in the modification of behavior of normal and deviant individuals. Applications to problems of development, mental retardation, delinquency, behavior disorder, vocational training, and social interaction. Prerequisite: Psch. 350 or the equivalent.
- 459. Seminar in Experimental Psychology. 2 hours.** May be repeated. Systematic review of special topics, with emphasis on current research and theoretical development. Prerequisite: Consent of the instructor.
- 470. Theories of Learning. 4 hours.** Historical and methodological analysis of theoretical formulations of learning. Prerequisite: Psych. 350.
- 472. Theories of Personality. 4 hours.** Same as Soc. 418. Contemporary theoretical formulations concerning personality and their evidential basis. Prerequisite: Psch. 350 or 352 or consent of the instructor.
- 479. Seminar: Theoretical, Historical, and Philosophical Issues in Psychology. 2 hours.** Same as Hist. 469 and Phil. 479. May be repeated. Systematic review of special topics, with emphasis on current approaches and interpretations. Prerequisite: Consent of the instructor.
- 480. Behavior Disorders in Children. 4 hours.** Major types of maladjustment in childhood. Emphasis on the emotional, motivational, and intellectual difficulties of the culturally deprived. Prerequisite: Consent of the instructor.
- 482. Psychological Appraisal: Intellectual Functions. 4 hours.** Theory, research, and techniques relating to psychological assessment of intellectual abilities and disabilities. Training in the administration, scoring, and interpretation of standard test methods. Prerequisites: Psch. 243 or the equivalent and consent of the instructor.
- 484. Psychological Appraisal: Personality. 4 hours.** Theory, research, and techniques relating to psychological assessment of personality. Training in the administration, scoring, and interpretation of structured tests and projective techniques. Prerequisites: Psch. 482 and consent of the instructor.
- 485. Practicum in Psychological Appraisal. 2 hours.** May be repeated. Supervised practice in psychodiagnostic testing in various facilities associated with the graduate training program in clinical and counseling psychology. Prerequisites: Concurrent registration in Psch. 482 or 484 and consent of the instructor.
- 486. Social and Cultural Factors in Health and Disease. 4 hours.** Same as Soc. 452. Methods of social epidemiology as applied to chronic and acute disease; psychosocial factors in illness; individual and social reactions to health and disease. Prerequisites: Psch. 380 or Soc. 351 or the equivalent.
- 489. Seminar in Psychological Appraisal. 2 hours.** May be repeated. Systematic review of special topics, with emphasis on current research, methods, and theories. Prerequisite: Consent of the instructor.
- 490. Colloquium in the Teaching of Psychology. No credit.** Registration open to departmental assistants only. Problems and methods of teaching at the college

level. Group discussion techniques; task analysis; test construction and analysis; curricular materials.

- 495. Individual Research. 2 to 8 hours.** May be repeated. Research on special problems not included in graduate thesis. Prerequisite: Consent of the instructor.
- 499. Thesis Research. 0 to 16 hours.** May be repeated. Research on topic of graduate thesis. Prerequisites: Consent of the instructor and approval of research prospectus by thesis committee.

## **Courses for Graduate and Advanced Undergraduate Students**

- 310. Advanced Social Psychology. 4 hours.** Same as Soc. 315. A critical analysis of empirical research on social perception, communication and influence, group structure, role analysis, and socialization processes. Prerequisites: Soc. 185 or Psch. 243 and 16 hours in sociology or psychology.
- 315. Psychology of Social Influence. 4 hours.** Methodology, results, and interpretations of studies of the influence of social variables on attitude development and modification, acculturation, perception, and judgment. Prerequisite: Consent of the instructor.
- 317. Social Development. 4 hours.** Theories and research on the effects of social evaluation, imitation, and observational learning, and other social factors on the development of cognition, language, and attitudes in children and adolescents. Emphasis on the consequences of impoverished or atypical social environments. Prerequisites: Psch. 220 or the equivalent and consent of the instructor.
- 318. Experimental Social Psychology. 4 hours.** Critical survey of experimental studies of independence, power, influence, and social learning and perception, and other aspects of social behavior, with laboratory practicum and demonstrations. Prerequisites: Psch. 115, 241, and 243 or the equivalents and consent of the instructor.
- \*323. Psychology of the Exceptional Child. 4 hours.** Methods, results, and interpretations of studies of physically, intellectually, and emotionally deviant children, with special references to their implications for education and behavior modification. Prerequisites: 12 hours of psychology including Psch. 220 or the equivalent or consent of the instructor.
- 332. Personnel Psychology. 4 hours.** Systematic study of the development and utilization of psychological techniques of personnel selection, classification, and assessment. Prerequisites: 12 hours of psychology including Psch. 230; and Psch. 240 or 243 or the equivalents; or consent of the instructor.
- \*343. Advanced Statistics. 4 hours.** Elementary probability theory, empirical and theoretical distributions, points and interval estimation, hypotheses testing. Prerequisite: 12 hours of psychology including Psch. 243 or the equivalent or consent of the instructor.
- 345. Psychometric Applications. 4 hours.** Theory of psychological tests and measurement applied to problems of ability and personality testing; opinion sampling; reliability and validity; prediction and selection processes. Prerequisites: 12 hours of psychology including Psch. 243 or the equivalent or consent of the instructor.

- \*350. Learning and Conditioning. 4 hours.** Methods, results, and interpretation of experimental studies of basic learning processes in animal and human subjects. Prerequisites: 12 hours of psychology including Psych. 250 and 251 or the equivalents and consent of the instructor.
- 351. Programmed Learning. 4 hours.** Theory and research in the techniques, applications, and results of programmed instruction. Prerequisite: 12 hours of psychology including Psych. 224 or the equivalent or consent of the instructor.
- \*352. Motivation. 4 hours.** Methods, results, and interpretation of experimental studies of basic motivational processes in animal and human subjects. Prerequisites: 12 hours of psychology including Psych. 250 and 251 or the equivalents and consent of the instructor.
- \*354. Verbal Learning and Retention. 4 hours.** Methods, results, and interpretations of experimental studies of verbal learning, transfer, and retention. Prerequisite: Psych. 252 or consent of the instructor.
- 355. Higher Processes. 4 hours.** Methods, results, and interpretations of experimental studies of language behavior, problem solving, concept formation, and creativity. Prerequisites: 12 hours of psychology and consent of the instructor.
- \*356. Sensory Processes and Perception. 4 hours.** Methods, results, and interpretation of experimental studies of sensory and perceptual process. Emphasis on vision and audition. Prerequisite: 12 hours of psychology including Psych. 250 and 251 or the equivalents or consent of the instructor.
- 360. Human Factors. 4 hours.** Application of experimentally derived principles of behavior to the design of equipment for efficient use and operation. Sensory and perceptual processes, motor skills, and experimental methodology. Prerequisite: 12 hours of psychology including Psych. 250 and 251 or the equivalents or consent of the instructor.
- 361. Instrumentation in Psychology. 4 hours.** Use of transducers, programming equipment, and recording systems in psychological research. Prerequisite: Graduate standing or consent of the instructor.
- 362. Physiological Psychology. 4 hours.** Methods, results, and interpretation of experimental studies of physiological and neurochemical correlates of learning, motivation, and perception. Laboratory demonstrations and problems. Prerequisite: Consent of the instructor.
- \*370. Systems and Theories. 4 hours.** Critical introductory analysis of major historical systems and their representation in current theoretical issues. Prerequisites: 12 hours of psychology including Psych. 250 and 251 or the equivalents and consent of the instructor.
- \*380. Abnormal Psychology. 4 hours.** Forms and determinants of behavior and personality disorders. Prerequisite: 12 hours of psychology and consent of the instructor.
- \*382. Introduction to Psychological Assessment. 4 hours.** Systematic analysis of the nature of psychological tests and their application; introduction to intelligence, achievement, personality, and interest tests. Practice in administration and interpretation. Prerequisites: 12 hours of psychology including Psych. 243 or the equivalent and consent of the instructor.



- 399. Problems in Psychology. 2 to 12 hours.** May be repeated. Investigation of special problems under direction of a staff member. Prerequisites: Consent of the instructor and of the head of the department.

## **THE JANE ADDAMS GRADUATE SCHOOL OF SOCIAL WORK**

Mark P. Hale, Director.

W. Paul Simon, Assistant Director.

### **Professors**

Jennette R. Gruener, Mark P. Hale, Florence L. Poole, W. Paul Simon, Jane L. Wille.

### **Associate Professors**

Adelaide Dinwoodie, Margaret G. Holden, George W. Magner, Aleanor R. Merrifield, Barbara Moore, Mary Sullivan, Narayan Viswanathan.

### **Assistant Professors**

John L. Alderson, Claire Anderson, Eloise J. Cornelius, Frieda Engle, Kenneth Krause, Clarence Lipschultz, Seymour Mirelowitz, Christopher Narcisse, Naomi L. Tillman, Harvey Treger, Joan Wallace, Henriette Watson, Dorothy Young.

### **Instructors**

Nancy Morrison.

### **Lecturers**

Peter Baker, Mark Lepper, Robert Read Nunn, Max Samter.

The Jane Addams Graduate School of Social Work offers, on both the Chicago Circle and the Urbana campuses, a program of professional study leading to the degree of Master of Social Work. An identical program of academic studies and fieldwork is offered on each campus; groupwork training is available only at Chicago Circle. An undergraduate minor in social work is offered at Urbana; undergraduate courses are not offered at Chicago Circle.

The educational program of the Jane Addams School is designed to give the student the knowledge, skills, attitudes, and philosophy basic to all professional social work practice rather than merely to prepare him for positions in specific agencies. The curriculum is organized in four general areas: human growth and behavior, social work practice, social services, and research. The student spends an equal amount of his time in the classroom and in fieldwork.

In Chicago, fieldwork is concurrent with classwork. Students are usually placed in two distinctly different types of agencies. However, the second-year placement is usually made on the basis of the student's career interest and on the method (social casework or social groupwork) which he chooses to attain competence. Deference is, of course, given to any agency from which he may hold a scholarship. A demonstration project in social groupwork currently allows a second-year student to select either a group treatment or community oriented placement.

## Admission Requirements

A satisfactory undergraduate scholastic record, 20 hours in the social sciences, and evidence of personal suitability for the field are the basic requirements. Applicants whose undergraduate grade average for the final two years is less than 3.50 on a 5.00 scale are not considered. The admissions committee

also assesses promise for professional success in social work by evaluating emotional maturity as commensurate with age and experience, interest in and liking for people, ability to establish harmonious and helpful relationships, personal integrity as demonstrated by intellectual honesty and a sense of responsibility, and serious concern for improvement of the institutions of society.

Since the number of possible enrollments is limited and new students will be admitted only in the fall term, early application is advisable. Scholarship and fellowship aids are available through the School and through many public and private social agencies.

A bulletin about the School and application forms may be obtained by writing the Jane Addams School at Chicago Circle, P. O. Box 4348, Chicago, Illinois 60680. A listing of casework agencies and field instructors is included in the School bulletin.

## The Joint Program with McCormick Theological Seminary

A special curriculum has been arranged in cooperation with the McCormick Theological Seminary in Chicago through which students may simultaneously complete requirements for the degrees of Master of Social Work (casework or groupwork) and Bachelor of Divinity or Master of Arts in Christian Education or Master of Arts in Church and Community.

This program is for a limited number of students who plan to engage specifically in social services under religious auspices. It usually requires three years of graduate study at the Seminary and the School of Social Work. Financial assistance is available. Applicants must be accepted by both institutions and must apply to both. Seminary applicants should address: Department of Church and Community, McCormick Theological Seminary, 2330 North Halsted Street, Chicago, Illinois 60614.

## Degree Requirements (Master of Social Work)

*Hours:* Candidates must successfully complete 96 quarter hours of graduate work (including the work in each of the four general areas) with a cumulative grade-point average of 3.75. An average of 3.75 is required if a candidate is to remain in good standing. Those whose average falls below 3.75 in any quarter will be placed on probation and will be required to achieve a 3.75 minimum cumulative average by the end of the year.

*Residence:* A minimum of 36 quarter hours of resident credit is required; the candidate must carry a full program (12 quarter hours) at Chicago Circle for at least three consecutive quarters. A maximum of 48 hours of credit may be transferred for work taken elsewhere.

*Time Limit:* All requirements must be completed within six years. Military service is deducted. Exceptions may be made only in unusual circum-

stances. Several plans have been developed for spreading the degree program over a three-year period with one year devoted to full-time work in residence.

## A Typical Program in the Jane Addams Graduate School of Social Work Chicago Circle Campus

<u>First Year</u>	<u>Quarter Hours</u>	<u>Second Year</u>	<u>Quarter Hours</u>
<u>First Quarter</u>		<u>First Quarter</u>	
SocW. 401 or 411	3	SocW. 404 or 414	3
SocW. 493	3	SocW. 444	3
SocW. 441	4	SocW. 474	2
SocW. 471	3	SocW. 496	2
SocW. 431	4	SocW. 434	6
	<u>17</u>		<u>16</u>
<u>Second Quarter</u>		<u>Second Quarter</u>	
SocW. 402 or 412	3	SocW. 405 or 415	3
SocW. 494	3	SocW. 445	3
SocW. 442	4	SocW. 475	2
SocW. 472	3	SocW. 497	2
SocW. 432	4	SocW. 435	6
	<u>17</u>		<u>16</u>
<u>Third Quarter</u>		<u>Third Quarter</u>	
SocW. 403 or 413	3	SocW. 406 or 416	3
SocW. 425	2	SocW. 476	2
SocW. 443	4	SocW. 498	2
SocW. 473	3	Elective	3
SocW. 433	4	SocW. 436	6
	<u>16</u>		<u>16</u>

### Courses for Graduate Students

- 401. Social Casework I. 2 to 4 hours.** Analysis and study of the underlying philosophy, concepts, generic principles, and methods of social casework; role of the case worker in offering service through a professional relationship.
- 402. Social Casework II. 2 to 4 hours.** Continuation of development of social casework concepts and principles through analysis of case material from secondary settings. Consideration of psychological and cultural factors which affect the treatment process. Analysis of the interconnectedness of relationship, study-diagnosis, and treatment phases of social casework. Prerequisite: SocW. 401.
- 403. Social Casework III. 2 to 4 hours.** Continues SocW. 402. Emphasis on increased independent analysis of case material and use of relevant source material related to specific cases. Learning experiences are arranged to assist the student to acquire greater integration of philosophy, concepts, and principles in social casework. Prerequisite: SocW. 402.
- 404. Social Casework IV. 2 to 4 hours.** Continuing study of casework principles and methods. Emphasis on work with clients with complex emotional and personality



problems, the stresses which impair social and ego functioning and the effects of agency setting. Prerequisite: SocW. 403.

- 405. Social Casework V. 2 to 4 hours.** Casework methods adapted to treatment of children and their parents in child-serving agencies, including schools, child-placing agencies, and child-guidance clinics and hospitals. Collaborative work with other disciplines and the role of the social worker as a consultant and consultee are examined. Prerequisite: SocW. 404.
- 406. Social Casework VI. 2 to 4 hours.** Casework theory and practice focused on multiple-client interviewing and family diagnosis and treatment. Current issues in casework theory and the changing role of the caseworker in a changing society are discussed. Prerequisite: SocW. 405.
- 411. Social Group Work I. 2 to 4 hours.** Group work methods, with focus on the worker's problems and procedures in understanding the group, its objectives, and its relationship to the agency. Beginning formulation of the worker's role in reference to assessment, interaction, analysis, and small-group theory.
- 412. Social Group Work II. 2 to 4 hours.** Further emphasis on group methods, with intensive application of understanding and working with individuals in the group and in the agency. Social work practice with groups, including relationship, use of program, and the helping processes. Prerequisite: SocW. 411.
- 413. Social Group Work III. 2 to 4 hours.** The integration of concepts in the worker's role with the individual and the group; the referral processes. The worker's role as a strategy of intervention is developed. Prerequisite: SocW. 412.
- 414. Social Group Work IV. 2 to 4 hours.** Advanced principles of social group work in direct service with the group, advanced group theory, and concepts of group stress and crisis situations. The development of criteria for analysis of the worker's role. Prerequisite: SocW. 413.
- 415. Social Group Work V. 2 to 4 hours.** Further development of the concepts of the worker's role in direct service, with refinements illustrated from analysis of treatment groups in special settings. Work with individuals, family groups, and interdisciplinary elements in collaboration. Prerequisite: SocW. 414.
- 416. Social Group Work VI. 2 to 4 hours.** The final course in the group-work sequence. Assists the student in the integration of method and analysis of his own practice. Emphasis is on the wider role of organizing and supervising group services. Selected concepts of subexecutive and supervisory functions are identified. Current issues and new modalities in social work with groups are developed. Prerequisite: SocW. 415.
- 425. Community Organization. 2 to 4 hours.** Principles, concepts, and methods of community organization in social work at the neighborhood, local, state, national, international levels.
- 431. Field Instruction I. 3 to 6 hours.** The student is assigned to a social agency where, under the supervision of a field instructor, he carries selected cases or groups for direct service to the agency clientele. Prerequisite: SocW. 401 or 411; must precede or be taken concurrently.
- 432. Field Instruction II. 3 to 6 hours.** The student is assigned to a social agency where, under the supervision of a field instructor, he carries selected cases or groups for direct service to the agency clientele. Prerequisite: SocW. 402 or 412; must precede or be taken concurrently.

- 433. Field Instruction III. 3 to 6 hours.** The student is assigned to a social agency where, under the supervision of a field instructor, he carries selected cases or groups for direct service to the agency clientele. Prerequisite: SocW. 403 or 413; must precede or be taken concurrently.
- 434. Field Instruction IV. 4 to 8 hours.** The student is assigned to a social agency where, under the supervision of a field instructor, he carries selected cases or groups for direct service to the agency clientele. Prerequisite: SocW. 404 or 414; must precede or be taken concurrently.
- 435. Field Instruction V. 4 to 8 hours.** The student is assigned to a social agency where, under the supervision of a field instructor, he carries selected cases or groups for direct service to the agency clientele. Prerequisite: SocW. 405 or 415; must precede or be taken concurrently.
- 436. Field Instruction VI. 4 to 8 hours.** The student is assigned to a social agency where, under the supervision of a field instructor, he carries selected cases or groups, for direct service to the agency clientele. Prerequisite: SocW. 406 or 416; must precede or be taken concurrently.
- 441. Human Growth and Behavior I. 3 to 6 hours.** The major forces influencing the growth and behavior of the individual, from birth through adolescence. Socio-cultural, familial, physical, emotional, and intellectual factors as they enhance or retard social functioning. The relevance of this content to the profession of social work is constantly considered.
- 442. Human Growth and Behavior II. 3 to 6 hours.** The individual's growth and behavior from early through late adulthood. Considerations of the essential developmental tasks and central conflicts for each major life phase, with attention focused on differentiating kinds of knowledge about personality and social functioning. Prerequisite: SocW. 441.
- 443. Human Growth and Behavior III. 3 to 6 hours.** The nature and dynamics of social processes as related to growth and behavior. Study is centered on various groups within society — the family, class, ethnic, and caste — and the manner in which they influence individual personality development. The process of interaction and the meaning of membership within small groups is studied. Consideration is given to role expectations and the dynamics of small-group membership, particularly in the family. Attention is focused on the continuous process of change in group life and its effect on behavior. Prerequisite: SocW. 442.
- 444. Human Growth and Behavior IV. 3 to 6 hours.** Interrelationship of physical, emotional, and social aspects of selected diseases; implications for the patient, family, and community. Concept of "disease" as reflecting loss of equilibrium. Role of social work in collaboration with other disciplines concerned with provision of medical and rehabilitation services. Prerequisite: SocW. 443.
- 445. Human Growth and Behavior V. 3 to 6 hours.** Psychopathology, including neuroses, psychoses, character disorders, psychosomatic dysfunction, organic conditions, and mental retardation. Discussion of diagnosis and treatment methods, including psychotherapy, somatic and drug therapies, and social work. Prerequisite: SocW. 444.
- 461. Special Studies in Social Work I. 2 to 6 hours.** Independent or group study in areas of special interest; application of social work principles to special problems or settings.

- 471. Social Services and Welfare Policy I. 2 to 4 hours.** The function, nature, and scope of the social welfare institution. The social services as a response to social, personal, and economic problems of people. Effects of economic and social growth and change on the welfare enterprise.
- 472. Social Services and Welfare Policy II. 2 to to 4 hours.** SocW. 472 and 473 will cover current provisions and alternatives for their solution in the social security and money assistance programs. Prerequisite: SocW. 471.
- 473. Social Services and Welfare Policy III. 2 to 4 hours.** Continues SocW. 472. Prerequisites: SocW. 471 and 472.
- 474. Social Services and Welfare Policy IV. 2 to 4 hours.** Current provisions and critical evaluation of welfare policy issues; alternatives for their solution in the social services for the aged, children, court wards, and the mentally and physically ill. Prerequisites: SocW. 471, 472, and 473.
- 475. Social Services and Welfare Policy V. 2 to 4 hours.** Continues SocW. 474. Prerequisites: SocW. 471, 472, 473, and 474.
- 476. Administration in Social Work. 2 to 4 hours.** Principles, concepts, and processes in social work administration. Special emphasis on leadership, policy and decision making, planning, and program organization.
- 493. Social Research I. 2 to 4 hours.** Objectives of social research, design of experiments, and measurement and methods of collecting data.
- 494. Social Research II. 2 to 4 hours.** Continues SocW. 493. Design of questionnaires and schedules; methods of data analysis, including statistical hypothesis testing and applications of inferential techniques; interpretation of results; preparation of the report; review of selected studies. Prerequisite: SocW. 493.
- 495. Social Research III. 2 to 4 hours.** Seminar and tutorial as an aid to developing the research problem to be followed in the second year. Prerequisite: SocW. 494.
- 496. Research Project I. 2 to 4 hours.** Application of research methods to a social work problem in an individual or a group project. Prerequisite: SocW. 495.
- 497. Research Project II. 2 to 4 hours.** Application of research methods to a social problem in an individual or a group project.
- 498. Research Project III. 2 to 4 hours.** Application of research methods to a social work problem in an individual or a group project. Prerequisite: SocW. 497.

## **SOCIOLOGY**

### **Professors**

Robert L. Hall, Head of the Department; Robert E. Corley, Peter P. Klassen, Ethel Shanas.

### **Associate Professors**

Bernard H. Baum, M. Rue Bucher, John W. C. Johnstone, Roger W. Little, George J. McCall, Mildred A. Schwartz.

### **Assistant Professors**

Ozzie L. Edwards, John W. Martin, Valerie K. Oppenheimer, Gerald M. Swatez, Ronald C. VanderKooi, James L. Wilkins.



The Department of Sociology offers graduate work leading to the Master of Arts degree in general sociology with areas of specialization for research experience in medical, urban, and political sociology. The University's location in Chicago offers many opportunities for research. Facilities within the department include a Research Methods Laboratory and a Demography Laboratory. There is access to other valuable facilities within the city.

## Admission Requirements

*Grade-Point Average:* 4.00 (A=5.00) for the last two years of undergraduate work. Students whose average is between 3.75 and 4.00 may petition for consideration.

*Hours:* Students without strong undergraduate preparation in sociology are encouraged to apply if they meet the above standards. They will be required to complete extra courses to remedy deficiencies.

*Graduate Record Examination:* Satisfactory scores on the aptitude tests (Verbal and Quantitative).

Training in logic, the philosophy of science, mathematics, and statistics is strongly recommended for graduate students in sociology.

## Degree Requirements

Forty-eight quarter hours, including Sociology 400, 401, and 402, and 8 quarter hours in thesis research (Sociology 499); satisfactory completion of a thesis; satisfactory completion of a comprehensive examination.

## Courses for Graduate Students

- 400. Theory and Method in Sociology. 4 hours.** Detailed examination of middle-range theories, such as compliant behavior, status congruence, and intervening opportunities in migration; the means of bringing evidence to bear on them. Emphasis on the link between theoretical assertions and data. Required of all graduate majors. May be taken out of sequence with consent of the instructor. Prerequisite: Consent of the instructor.
- 401. Theory and Method in Sociology. 4 hours.** Continues Soc. 400. Detailed examination of middle-range theories, such as compliant behavior, status congruence, and intervening opportunities in migration; the means of bringing evidence to bear on them. Emphasis on the link between theoretical assertions and data. Required of all graduate majors. May be taken out of sequence with consent of the instructor. Prerequisite: Soc. 400 or consent of the instructor.
- 402. Theory and Method in Sociology. 4 hours.** Continues Soc. 400 and 401. Detailed examination of middle-range theories, such as compliant behavior, status congruence, and intervening opportunities in migrations; the means of bringing evidence to bear on them. Emphasis on the link between theoretical assertions and data. Required of all graduate majors. May be taken out of sequence with consent of the instructor. Prerequisites: Soc. 400 and 401 or consent of the instructor.

403. **Advanced Statistics in Sociology. 4 hours.** Analysis of contingency tables; multiple and partial, linear and nonlinear correlation; analysis of variance. Prerequisite: Soc. 303 or equivalent.
404. **Survey Research Methods. 4 hours.** Same as Psch. 441. Methods of sampling human populations; interviewing techniques; techniques of analyzing survey data; uses and limits of sample surveys in testing hypotheses; supervised participations in survey research. Prerequisite: Soc. 403 or consent of the instructor.
405. **Experimental Methods in Sociology. 4 hours.** Design and analysis of laboratory and field experiments on human groups and organizations; uses and limits of experiments in testing sociological hypotheses; supervised participation in experimental research. Prerequisite: Soc. 403 or consent of the instructor.
411. **Small Groups: Structure and Process. 4 hours.** Same as Psch. 411. Systematic survey of research and theory dealing with social interaction and social relationships in small groups; primary groups as agents of social influence and social control. Prerequisite: Consent of the instructor.
415. **Social Diffusion Processes. 4 hours.** Processes by which information or specific practices diffuse through society; acceptance of innovation; opinion leadership and diffusion of opinion; research examples from adoption of farm practices and new medical treatments. Prerequisite: Consent of the instructor.
416. **Theories of Social Behavior. 4 hours.** Prerequisite: Psch. 315, 317, or 318 or consent of the instructor.
418. **Theories of Personality. 4 hours.** Same as Psch. 472. Contemporary theoretical formulations concerning personality and their evidential basis. Prerequisite: Psch. 350 or 352 or consent of the instructor.
441. **Social Organization. 4 hours.** Analysis of selected social institutions such as the family, educational system, political structure and others; development and interrelationship of social institutions; function of various institutions in simple and complex societies. Prerequisite: Consent of the instructor.
452. **Social and Cultural Factors in Health and Disease. 4 hours.** Same as Psch. 486. Methods of social epidemiology as applied to chronic and acute disease; psychosocial factors in illness; individual and social reactions to health and disease. Prerequisite: Soc. 351 or Psch. 380.
462. **The Family in Middle and Later Life. 4 hours.** Later phases of the life cycle pertaining to intergenerational relations; demographic trends; living arrangements and the kin network; husband and wife in later life; filial responsibility and the American family. Prerequisite: Soc. 345 or 361.
466. **Voting Behavior. 4 hours.** Principal sociological research procedures for collecting data on voting behavior; assessment of their relative contributions to understanding of who votes, how they vote, and why. Prerequisite: Soc. 365 or consent of the instructor.
471. **Population Theory and Methods. 4 hours.** Critical examination of the nature and development of population theories; study of research techniques and application to problem areas. Prerequisite: Soc. 372 and 374, or consent of the instructor.
476. **Sociology of Urban Life. 4 hours.** Demographic, ecological, and social processes involved in the development of the urban community; emphasis on the

effects of urban development on these processes and the organization of human life in the city. Prerequisite: Soc. 376 or consent of the instructor.

- 499. Thesis Research. 0 to 16 hours.** Students registering for thesis research will register for credit under this number.

### **Courses for Graduate and Advanced Undergraduate Students**

- 303. Sociological Statistics. 4 hours.** Introduction to statistical tests of sociological hypotheses; estimation procedures; selected statistical procedures commonly used in sociology. Prerequisite: Soc. 263 or consent of the instructor.
- 315. Advanced Social Psychology. 4 hours.** Same as Psch. 310. Critical analysis of empirical research on social perception, communication and influence, group structure, role analysis, and socialization processes. Individual projects are required. Prerequisites: Soc. 185 or Psch. 243 and 16 hours in sociology or psychology.
- 317. Social Psychology of Theater. 4 hours.** Same as Spch. 317. Compares social psychological theories which are explicitly dramaturgical and theories of drama which are explicitly social. Considers dramatic works as social psychological events. Prerequisite: Soc. 130 or Psch. 115 or consent of the instructor.
- 331. Criminology. 4 hours.** The nature and extent of crime in American society; assessment and evaluation of the various factors and influences that lead to criminal behavior; various measures proposed for the control of criminal behavior. Prerequisite: 8 hours of sociology.
- 332. Juvenile Delinquency. 4 hours.** Various conceptions of the nature of juvenile delinquency and its causes; the juvenile-court movement; juvenile detention, treatment of juvenile offenders; delinquency control programs. Prerequisite: Soc. 331.
- 341. Social Stratification and Classes. 4 hours.** Nature and systems of differentiation and ranking in societies, emphasis on the class structure in the United States; life chances, prestige, status, power, and social mobility in the United States and other societies. Prerequisite: Soc. 263 or consent of the instructor.
- 343. Sociology of Education. 4 hours.** The relationship of the educational system to the social structure, major emphasis on the role of education in an advanced technological society. Prerequisite: 8 hours of sociology.
- 344. Industrial Sociology. 4 hours.** Analysis of industrial society and industrial institutions; the meaning of work and work relations and of the relationship between work and authority, with cross-cultural emphasis; sociological analysis of collective bargaining and of the impact of industrial and labor organizations on the community and on society. Prerequisite: 8 hours of sociology.
- 345. The Sociology of the Family. 4 hours.** The family as a social institution; its origin, its nature of kinship, its development, and its prospects. Prerequisite: 8 hours of sociology.
- 346. Sociology of Science. 4 hours.** Organization of the scientific enterprise; emergence of science as a social institution; interrelations with other institutions such as government, religion, economy, and the arts. Science as a social phenomenon; regularities in scientific behavior; consideration of both historical and contemporary material. Prerequisite: 8 hours of sociology or consent of the instructor.



- 347. Sociology of Complex Organizations. 4 hours.** Characteristics of business, government agencies, schools, hospitals, and other large-scale organizations, approaches used to study organizations, and theoretical and empirical analysis of organizational processes. Prerequisite: 8 hours of sociology or consent of the instructor.
- 348. Military Institutions in American Society. 4 hours.** Analysis of military institutions as components of the larger society; recruitment and socialization processes, behavior patterns in military organizations, paramilitary groups, and patriotic societies. Prerequisite: 12 hours of sociology or political science.
- 351. Medical Sociology. 4 hours.** Sociological contributions to medicine and public health; social organization and the organization of health services; the sociology of illness. Prerequisite: 8 hours of sociology.
- 361. Social Gerontology: Old People in America. 4 hours.** The aged: demographic trends, economic status, physical and social needs, family relationships. Prerequisite: 8 hours of sociology; senior standing.
- 365. The Sociology of Politics. 4 hours.** Sociological interpretation of leadership, citizen participation, and the development of political organizations, using comparative materials from the United States and other countries. Prerequisites: 12 hours of sociology or consent of the instructor.
- 366. Community Power Structure. 4 hours.** Analysis of the power structure of American communities; special emphasis on the relation between theoretical assumptions and research procedures in current community studies. Prerequisite: 12 hours of sociology or consent of the instructor.
- 372. Methods of Demographic Study. 4 hours.** Techniques for measurement of demographic variables such as migration, fertility, mortality; their application in population analysis. Prerequisites: Soc. 263 and 271.
- 373. Human Ecology. 4 hours.** The relationship between man and the natural environment. Emphasis on importance of population patterns and human institutions in adaptation. Prerequisite: Soc. 271 or consent of the instructor.
- 374. Demographic Analysis. 4 hours.** Detailed analysis of basic information concerning quantitative, qualitative, and distributive aspects of population; changes in these characteristics and their causes; implications of anticipated future changes. Prerequisites: Soc. 263 and 271.
- 376. Urban Sociology. 4 hours.** Review and analysis of recent research on urban areas, including their social organization, culture and subcultures, institutions, and contemporary problems. Prerequisites: Soc. 263 and 276.
- 385. History of Sociological Theory. 4 hours.** The major theoretical systems that have developed in the field, beginning with the foundations in philosophical and scientific thought before Comte and proceeding to some of the contemporary representatives in the field. Prerequisite: Soc. 263 or 8 hours of sociology.
- 389. Independent Study. 2 to 12 hours.** Supervised study projects for graduate students and honors undergraduates; may consist of extensive readings in specialized area of sociology or empirical research; exclusive of credit given under Soc. 499. Prerequisite: Soc. 263, 20 hours of sociology, and approval of the department.
- 390. Strategies of Research Design and Analysis. 4 hours.** The nature of sociological research; formulation of researchable problems; alternative research designs and procedures of data collection and analysis. Prerequisite: Soc. 263.

## FACULTY OF THE GRADUATE COLLEGE

ABELS, LARRY L.; Ph.D., Assistant Professor, Physics  
ADAMS, R. K.; M.S., Associate Professor, Architecture  
AGARWAL, GYAN C.; Ph.D., Assistant Professor, Systems Engineering  
AKS, STANLEY; Ph.D., Assistant Professor, Physics  
ALBERTI, FURIO; Ph.D., Associate Professor, Mathematics  
AMON, RENE; M.S., Assistant Professor, Architecture  
ANDERSON, AEMER D.; Ph.D., Assistant Professor, Energy Engineering  
ANDERSON, LOUISE; Ph.D., Assistant Professor, Biological Sciences  
ARZBAECHER, ROBERT C.; Ph.D., Associate Professor, Information Engineering  
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BAER, JEAN H.; Ph.D., Associate Professor, Education  
BAILEY, HAROLD W.; Ph.D., Professor, Mathematics  
BALLARD, RUTH M.; Ph.D., Assistant Professor, Mathematics  
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BARDACK, DAVID; Ph.D., Assistant Professor, Biological Sciences  
BARKER, TWILEY W., JR.; Ph.D., Professor, Political Science  
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BAUR, WERNER H.; *Dr. rer. nat.*, Associate Professor, Geology  
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BENNETT, JOSEPHINE W.; Ph.D., Visiting Professor, English  
BERGQUIST, VIOLET E.; M.A., Associate Professor, Spanish  
BERNSTEIN, SEYMOUR; Ph.D., Professor, Physics  
BETORET-PARIS, EDUARDO; Ph.D., Associate Professor, Spanish  
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BLACKBURN, NORMAN; Ph.D., Professor, Mathematics  
BLEWITT, THOMAS H.; Sc.D., Professor, Materials Engineering  
BLUMENFELD, DAVID C.; Ph.D., Assistant Professor, Philosophy  
BODMER, ARNOLD R.; Ph.D., Professor, Physics  
BOGARTZ, WILLIAM H.; Ph.D., Visiting Associate Professor, Psychology  
BOHANNAN, LAURA A.; Ph.D., Associate Professor, Anthropology  
BOND, JAMES A.; Ph.D., Assistant Professor, Biological Sciences  
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BOYER, JOSEPH H.; Ph.D., Professor, Chemistry  
BRODKEY, JERALD S.; M.D., Assistant Professor, Information Engineering  
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BROWN, THOMAS H.; Ph.D., Associate Professor, Chemistry  
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BUCHER, MARY RUE; Ph.D., Associate Professor, Sociology  
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BURIAN, KURT; Ph.D., Associate Professor, Information Engineering  
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BURSTEIN, ALVIN G.; Ph.D., Associate Professor, Psychology

CARHART, RICHARD A.; Ph.D., Assistant Professor, Physics  
 CARLIN, RICHARD L.; Ph.D., Associate Professor, Chemistry  
 CARTWRIGHT, ROSALIND D.; Ph.D., Professor, Psychology  
 CENSOR, DAN; Ph.D., Assistant Professor, Information Engineering  
 CHANG, YAO W.; Ph.D., Assistant Professor, Materials Engineering  
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 CHOW, JOSEPH C. F.; Ph.D., Assistant Professor, Energy Engineering  
 CHUNG, PAUL M.; Ph.D., Professor, Energy Engineering  
 CLARK, PRISCILLA P.; Ph.D., Assistant Professor, French  
 COLACO, LOUIS J.; Ph.D., Lecturer, Architecture  
 COLEMAN, PETER J.; Ph.D., Associate Professor, History  
 COLEMAN, RAYMOND W.; Ph.D., Professor, Economics and Management  
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 CONRAD, ROBERT E.; Ph.D., Assistant Professor, History  
 CONROY, MARY E.; Ph.D., Assistant Professor, History  
 CORLEY, ROBERT E.; Ph.D., Professor, Sociology  
 CORLISS, JOHN O.; Ph.D., Professor, Biological Sciences  
 CORNELIUS, ELOISE J.; M.A., Assistant Professor, Social Work  
 CRANE, ROBERT M.; Ed.D., Associate Professor, Education  
 CRONIN, CONSTANCE; Ph.D., Assistant Professor, Anthropology  
 CURRIE, LEONARD J.; M.Arch., Professor, Architecture  
 CURTIS, HERBERT J.; Ph.D., Professor, Mathematics  
 CUTSHALL, ALDEN D.; Ph.D., Professor, Geography  
  
 DAVIS, JOHN D.; Ph.D., Associate Professor, Psychology  
 DEAM, EDWARD L.; M.Arch., Professor, Architecture  
 DE FIGUEIREDO, DJAIRO G.; Ph.D., Associate Professor, Mathematics  
 DEMAR, ROBERT E.; Ph.D., Associate Professor, Geology  
 DERRICK, LUCILE; Ph.D., Professor, Economics and Quantitative Analysis  
 DICKIE, GEORGE T.; Ph.D., Professor, Philosophy  
 DICKINSON, DONALD H.; Ph.D., Professor, Speech and Theatre  
 DINKINES, FLORA; Ph.D., Professor, Mathematics  
 DOHERTY, WILLIAM E.; Ph.D., Assistant Professor, English  
 DOMAGALA, ROBERT F.; M.S., Associate Professor, Materials Engineering  
 DOMINOWSKI, ROGER L.; Ph.D., Assistant Professor, Psychology  
 DONALDSON, JAMES A.; Ph.D., Assistant Professor, Mathematics  
 DONER, DEAN B.; Ph.D., Professor, English  
 DOYLE, JAMES M.; Ph.D., Associate Professor, Materials Engineering  
 DRAINE, EDWIN H.; Ph.D., Associate Professor, Geography  
 DWINGER, PHILIP; Ph.D., Professor, Mathematics  
 DYSON, VERENA H.; Ph.D., Assistant Professor, Mathematics  
  
 EARGLE, DOLAN H. JR.; Ph.D., Assistant Professor, Chemistry  
 EDELSTEIN, ALAN S.; Ph.D., Associate Professor, Physics  
 EDIE, CAROLYN A.; Ph.D., Associate Professor, History  
 EDWARDS, OZZIE L.; Ph.D., Assistant Professor, Sociology  
 ELWERT, BERT E.; Ph.D., Assistant Professor, Economics and Management  
 ENGEL, FRIEDA; M.S., Visiting Assistant Professor, Social Work  
 EPPERSON, DAVID C.; Ph.D., Professor, Education  
  
 FARBER, ISADORE E.; Ph.D., Professor, Psychology  
 FEINSTEIN, IRWIN K.; Ph.D., Professor, Mathematics  
 FELDMAN, LAURENCE P.; Ph.D., Assistant Professor, Marketing  
 FIELDS, BEVERLY; Ph.D., Assistant Professor, English  
 FINER, HERMAN; D.Sc., Visiting Professor, Political Science



FINNEY, MILDRED I.; Ph.D., Associate Professor, Geography  
FISHER, JAMES S.; Ph.D., Assistant Professor, Geography  
FONG, PAUL; Ph.D., Associate Professor, Mathematics  
FORDHAM, SHELDON L.; Ed.D., Professor, Physical Education for Men  
FOULSER, DAVID A.; Ph.D., Assistant Professor, Mathematics  
FOX, SAMUEL; Ph.D., Professor, Accounting  
FRANK, EVELYN; Ph.D., Professor, Mathematics  
FREEDMAN, PHILIP E.; Ph.D., Assistant Professor, Psychology  
FREEMAN, SUSAN T.; Ph.D., Assistant Professor, Anthropology  
FRENCH, ROBERT W.; Ph.D., Professor, Economics and Management  
FRIEDLANDER, ROBERT A.; Ph.D., Assistant Professor, History

GADLIN, HOWARD; Ph.D., Assistant Professor, Psychology  
GARABEDIAN, HENRY L.; Ph.D., Professor, Energy Engineering  
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